Russian-German Cooperation SYSTEM LAPTEV SEA:

The Expedition LENA 2004

by the participants of the expedition

edited by Dirk Wagner and Dmitry Yu. Bolshiyanov

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Acknowledgements

The Russian-German Expedition LENA 2004 was a successful and memorable field campaign in the Siberian Arctic. In this year we had the chance to observe the fascinating process of the Lena River break up. Within the scope of the Russian-German Cooperation we continued our research on permafrost related processes and on the microbial world in extreme environments. LENA 2004 brought up new ideas for the continuation our long-term ecological studies and first plans for the next expedition to the Lena Delta in 2005.

The expedition LENA 2004 would not have been possible without the help and support of all our colleagues and friends in Moscow, St. Petersburg, Yakutzk and Tiksi. We wish to thank *Dimitri V. Melnitschenko*, *Viktor A. Dobrobaba*, *Alexander Y. Gukov* and all the people from Tiksi – they gave us the feeling to leave the Lena Delta not only as interested scientists but also as friends. Our special gratitude goes to *Alexander Y. Dereviagin* for his warm welcome in Moscow and for making impossible things possible and *Mikhail N. Grigoriev*, who welcomed us in Tiksi with a small but wonderful dinner on the first evening on the other side of the polar circle.

We thank several Russian, Yakutian and German institutions and authorities for their interest and support. In particular, we wish to mention the Hydro Base, the Lena Delta Reserve in Tiksi and the crew from the helicopter number 93 in appreciation of their help.

We thank the Russian Ministry for Science and Technical Policy of the Russian Federation, the Federal Ministry of Education and Research of Germany and the Directorate of the Alfred Wegener Institute for Polar and Marine Research which enabled the expedition LENA 2004.

1 Introduction

Dirk Wagner and Dmitry Yu. Bolshiyanov

The Laptev Sea and its hinterland – especially the Lena Delta – is one of the key regions for the understanding of the dynamic of the Arctic climate system. On the basis of previous investigations of the Russian-German Cooperation SYSTEM LAPTEV SEA 2000 (1998-2002) many results for the climate reconstruction of the late Quaternary and the understanding of the modern permafrost system in the Siberian Arctic were obtained and presented in a collection of papers (e.g. Rachold, 2002; Andreev et al., 2004; Kobabe et al., 2004; Schirrmeister et al., 2003; Hubberten et al., 2004; Wagner et al., 2005). The investigations indicate the close interaction of the coupled land-ocean system of the Laptev Sea with the Siberian hinterland. The present knowledge shows that environmental changes in this area do not only affect the Arctic region but also contribute to variations in the global climate system.

Within the framework of the Russian-German cooperation several expeditions to the Lena Delta, the Laptev Sea coastal region and the New Siberian Islands have been carried out since 1998 (e.g. Rachold and Grigoriev, 1999; Pfeiffer and Grigoriev, 2002; Grigoriev et al., 2003; Schirrmeister et al., 2004). Based on the experience and results of almost one decade of successful research in the Lena Delta region, the main focus of the seventh expedition was on trace gas flux measurements (CH_4, CO_2), to gain more insights into the relationships of structure and function of microbial communities involved in carbon fluxes and on hydrobiological and geomorphological processes. Furthermore, within the scope of a new DFG (German Science Foundation) project entitled "*Tolerance Limits of Methanogenic Archaea from Terrestrial Permafrost*" first physiological stress experiments were performed during the field campaign which contribute to the research topic of Astrobiology. The scientific work was carried out by three interdisciplinary teams of 6 Russian and 7 German scientists from spring to autumn 2004 (Chapter 2.2).

2 Expedition Itinerary

Dirk Wagner and Dmitry Yu. Bolshiyanov

2.1 Study Site

The study site of Samoylov Island (Siberia) is located within the Lena Delta, which represents the largest delta of the circum-arctic land masses, formed by the Lena River. The Lena Delta is located on the Laptev Sea coast between the Taimyr Peninsula and the New Siberian Islands (Figure 2-1). The delta occupies an area of about 32,000 km^2 and is characterized by a network of smaller and larger rivers and channels as well as more than 1500 islands. The delta can be divided into three geomorphologically different terraces (Are and Reimnitz, 2000; Schwamborn et al., 2002): (i) the oldest terrace was formed in the middle to late Pleistocene and is fragmentarily exposed (30–55 m a.s.l.) in the southern part of the delta. The terrace consists of ice-complexes containing fine-grained silty sediments with a high content of segregated ice. The ice-complex moreover includes enormous layers of organic-rich material and less decomposed peaty material, (ii) Arga Island, the western part of the delta (20–30 m a.s.l.) is characterized by coarse-grained sandy sediments and a multitude of deep lakes, which were formed in the late Pleistocene to late Holocene, (iii) the eastern terrace is regarded as the currently active part of the Lena Delta. The latter is of a middle Holocene age with several modern flood plains (1–12 m a.s.l.) at the base. The landscape of the delta is characterized by the patterned ground of ice-wedge polygons in different development stages (Müller, 1997). The entire delta is situated in the zone of continuous permafrost with a thickness of about 500–600 m (Romanovskii and Hubberten, 2001).

Figure 2-1: Map showing the Lena Delta located at the north-eastern coast of Siberia between the Taymyr Peninsula and the New Siberian Islands.

Samoylov is a representative island in the active and youngest part (8000–9000 years) of the Lena Delta and covers an area of about 1200 ha (Figure 2-2). The western coast of the island is characterized by modern accumulation processes (fluvial and aeolian sedimentation). Three flood plains can be distinguished, which differ in their flooding frequency and vegetation coverage. The texture of accumulated sediments is dominated by the sand fraction (fine to medium). In contrast, the eastern coast of Samoylov is dominated by erosion processes, which form an abrasion coast. This part is composed of middle Holocene deposits, which cover about 70% of the total area of the island. Our studies of trace gas fluxes (CH_4 and CO_2) and microbial processes and community structures were carried out within this terrace, which is dominated by active ice wedges with low-centred polygons. The topography is determined by this patterned ground and shows a distinct micro-relief of polygon rims and polygon depressions.

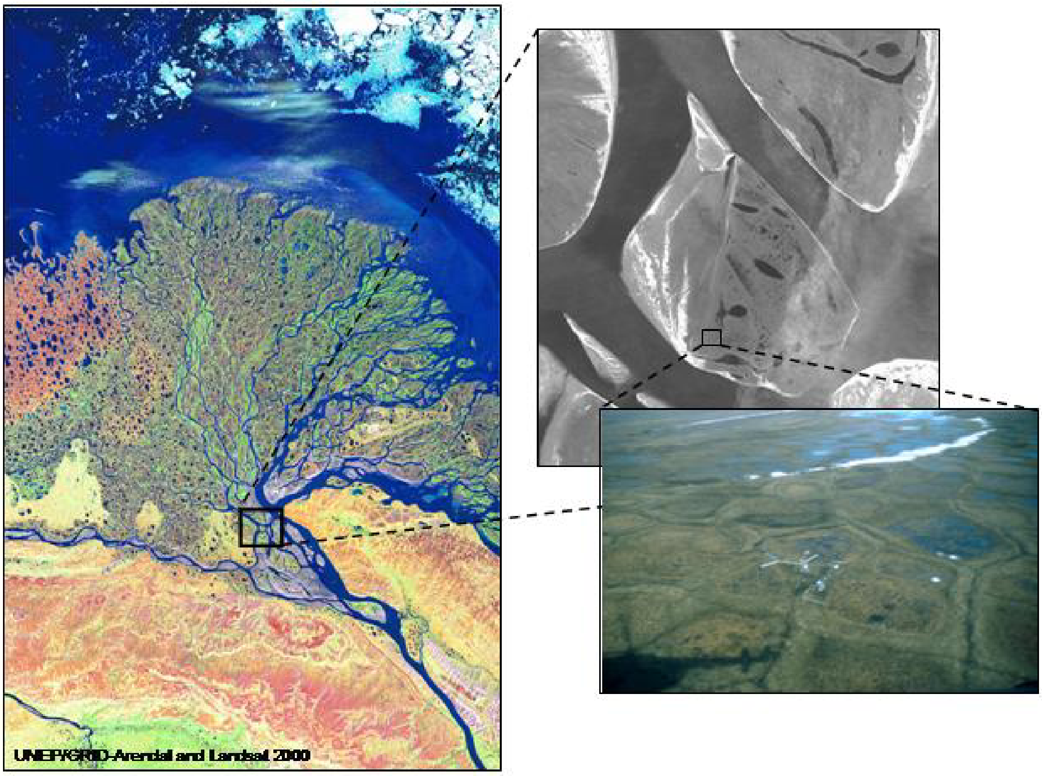

Figure 2-2: The Lena Delta with the location of the investigation area on Samoylov Island (N 72°22' / E 126°29') and a view from the helicopter on the long-term study site.

Due to the micro-relief, soil and vegetation characteristics vary in rapid succession. The soils of the investigation site are characterized by very homogeneously spread soil units: the polygon rims are dominated by *Glacic Aquiturbels*, whereas the prevalent soil type of the polygon depressions are *Typic Historthels* classified according to the US Soil Taxonomy (Soil Survey Staff, 2003). The peaty soils of the polygon depression are characterized by a water level near the soil surface and the predominantly anaerobic accumulation of organic matter. The drier soils of the polygon rim show a distinctly deeper water level, lower accumulation of organic matter and pronounced cryoturbation properties. The vegetation of the polygon rim is dominated by the dwarf shrub *Dryas punctata* and the mosses *Hylocomium splendens* and *Timmia austriaca*, whereas the polygon depression is dominated by hydrophytes like various *Carex* species and different moss species (e.g. Limprichtia revolvens, Meesia longiseta). The thaw depth of the soils varied between 30 and 45 cm (rim, depression), respectively.

2.2 Research Teams

Within the framework of the expedition LENA 2004 three teams worked from the middle of May until the beginning of September on Samoylov Island, Siberia (N 72°22, E 126°28). The interdisciplinary team included microbiologists, molecular ecologists, soil scientists, geologists, geomorphologists, geocryologists, hydrologists and hydrobiologists (Table 2-1). Their research was focused on modern processes in the Lena Delta. Additionally to this research, studies on recent cryogenesis were accomplished in Yakutzk (N 62°19, E 129°29) in the scope of this expedition.

Table 2-1: List of participants

Name	Email	Institute	Team
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Colleagues involved in the organisation and logistics of the field work 2004, that did not participate in the expedition.

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PIY: Permafrost Institute, Russian Academy of Science
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SPbSU: St. Petersburg State University
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Team 1 (May 13 – June 25):

Team 1 concentrated on micrometeorological field studies in the polygonal tundra on Samoylov Island during the thawing period of the active layer of permafrost. Turbulent fluxes of momentum, energy, water vapour, carbon dioxide and methane were analysed using the eddy covariance technique complemented by meteorological and soil-physical measurements (➔ Chapters 3.4, 3.5 and 3.6).

Team 2 (June 22 – July 28):

Team 2 continued the long-term measurements of methane emission from low-centred ice-wedge polygons, which started in 1999. Furthermore, the structure and function of microbial communities, the hydrobiology of lake ecosystems and the hydrology and geomorphology of the Lena River were studied (➔ Chapters 3.1, 3.2, 3.3, 3.7, 3.8 and 3.9).

Team 3 (August 17 – August 26 Yakutzk, August 27 – September 2 Samoylov):

Team 3 investigated recent cryogenic processes on a long-term study site on Samoylov Island (Lena Delta) and near Yakutzk. The set up was installed in 2002 (➔ Chapter 3.10 and 4).

2.3 General Logistics

The general logistics of the expedition LENA 2004 were jointly organized by the Permafrost Institute Yakutsk (*Mikhail N. Grigoriev*), the Arctic and Antarctic Research Institute in St. Petersburg (*Dmitry Yu. Bolshiyanov*) and the Alfred Wegener Institute for Polar and Marine Research in Potsdam (*Waldemar Schneider*).

Logistic operations were organized by the company Juniks XXI WEK in Moscow and by the Hydro Base (*Dimitri V. Melnitschenko*) in Tiksi. The Lena Delta Reserve in Tiksi provided the base on Samoylov Island for living and working and organized the extension of the station (see 2.4) financed by the Alfred Wegener Institute. The total amount of cargo was 2.5 t whereof 1.2 t were food.

2.4 Extension of the Research Station Samoylov

The extension of the Samoylov Station, which has been planned together with the Lena Delta Reserve since 2001, was started in 2004 and finalized in spring 2005.

Figure 2-3: Research station on Samoylov Island (Lena Delta) with the main building on the left and the extension on the right side.

The annex was built in a 90° angle with the existing building (Figure 2-3). It was connected with the old station through the anteroom. The new hut features additional room of 68 m^2, which was separated into three sleeping rooms and one large living room (Figure 2-4). Special attention was paid to the insulation of the annex to ensure possible future research activities in the Lena Delta also during the winter season. The extended station provides space for eight scientists during winter time and up to 16 people in the summer period by using additional tents. For the power supply a 6 KVA diesel generator (Honda ECT 6D) is used. The power rating of the generator supplies sufficient energy for the general equipment of the station and the scientific instruments and still holds reserves for the future. In order to have a power supply independent from the diesel generator during periods of low power consumption, a wind generator

(AIR 403;12V, 400W), a set of lead batteries (12V, 390Ah) and an AC converter (12V/220V, 400W) were installed. This system supplies sufficient energy for the laboratory lights, notebooks, chargers and other low energy devices. Drinking water supply is realized by a pumping system transporting the water from a nearby lake to the station.

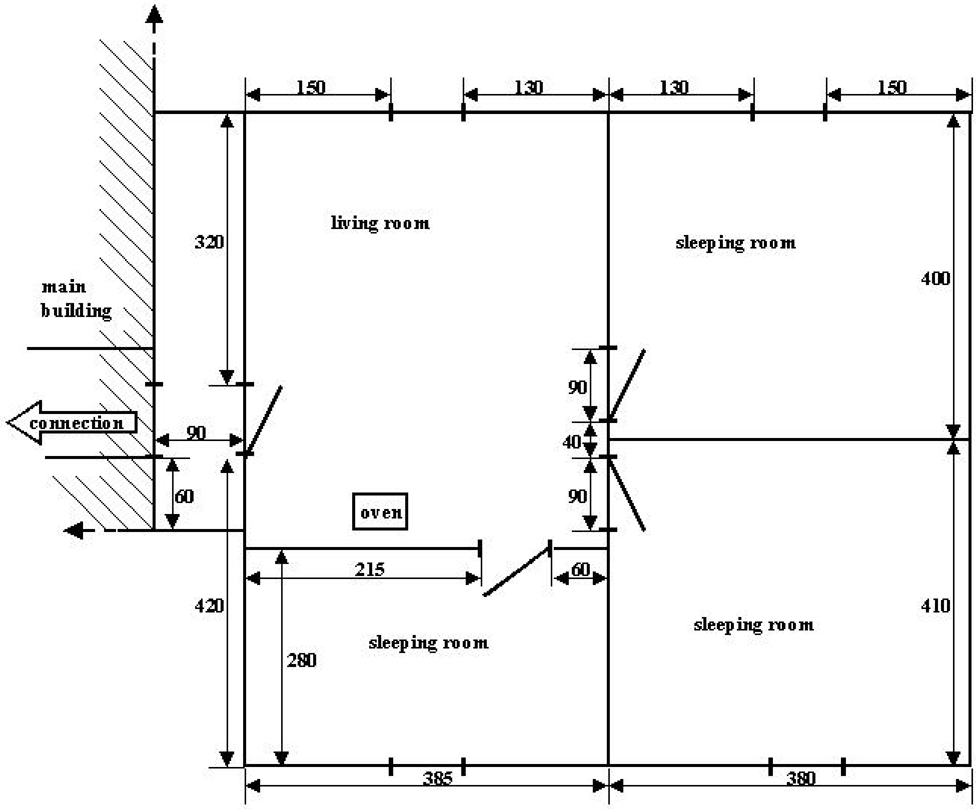

Figure 2-4. Floor map of the research station extension on Samoylov Island (Lena Delta).

For the scientific work the station is fitted out with two laboratories. The universal lab has a size of about 15 m^2 and is equipped with two working benches with a total length of 6.5 m. The second laboratory is about 12 m^2 and equipped with a gas chromatograph (Chrompack CP-9003; FID, WLD) and a hydrogen generator (Domnick Hunter UHP-20H) for trace gas analyses. The length of the working benches is 6 m. Distilled water for extraction and sample preparation is provided by the Lena Delta Reserve in Tiksi and transported in cans to the station.

3 Trace Gas Fluxes and Ecological Studies in Permafrost Environments of the Central Lena Delta

3.1 Introduction

Dirk Wagner and Andreas Gattinger

Global change is more pronounced in the Arctic than in any other region of the world. Currently observed changes such as a temperature rise twice as high as the global average or the distinctive decrease of Arctic sea ice underline the sensitivity of the Arctic environment. Biogeochemical cycles will be affected by these changes to a still unknown extend and with an unknown outcome.

Certain key processes of global biogeochemical cycles (e.g. C, N, S, Fe) are carried out exclusively by highly specialized microorganisms (e.g. methanogenic archaea, methylotrophic and nitrifying bacteria, sulphate-reducers), which play the quantitatively dominant role in mineralisation processes (Watson et al., 1989; Whiteman et al., 1992; Widdel and Bak, 1992). Although their metabolism is well studied, little is known about the control of element fluxes by these individual groups in Arctic environments, about the role of microbial diversity for the functioning and stability of the system and about the reaction of these microorganisms to changing environmental conditions. Generally, each habitat shows a characteristic composition of the microbial community, depending on the environmental conditions (Marchensi et al., 2001). Hence, the knowledge about the current element fluxes, their control by the bacterial communities, and their reaction to environmental change is crucial for understanding current biogeochemical cycles and predicting their future development.

The biggest global carbon pools are carbonates, gas deposits and gas hydrates. The largest accessible carbon pools are organic matter stored in the permafrost regions of the Arctic where more than 14 % of the global carbon is accumulated in soils and sediments (Post et al., 1982). The microbial methane production (methanogenesis) is one of the most prominent microbiological processes during the anaerobic decomposition of organic matter. While the oxidation of methane by methanotrophic bacteria is one of the major sink for methane in Arctic wetlands. The relevance of Arctic carbon reservoirs is highlighted by current climate models that predict significant changes in temperature and precipitation in the northern hemisphere (Kattenberg et al., 1996). Particularly, the degradation of permafrost and the associated release of climate relevant trace gases from intensified turnover of organic carbon and from destabilised gas hydrates represent a potential environmental hazard.

3.2 Long-term Studies on Methane Fluxes

Dirk Wagner and Daria Morozova

Daily measurements of net methane (CH_4) fluxes, thaw depth, water level and soil temperature were carried out from the end of May to the end of July 2004 at the low-centre polygon site. This investigation pertained to an ongoing long-term study of trace gas emissions, which started in 1998. The flux measurements were determined using five static chambers (PVC transparent, 12.5 l) for the polygon rim and depression, respectively (Figure 3-1). The chambers consisted of a 50 x 50 cm stainless steel base installed permanently 15 cm into the active layer. Water filled channels on top of the steel base provided airtight seals of the chamber components. Each chamber was fitted with four ports connected with two perforated pipes fixed inside the chamber. Chamber headspace was sampled over 30 min by pumping headspace air through a gas collecting jar connected with gastight tubes (Figure 3-2). CH_4 fluxes were calculated from the chamber volume and the linear increase in CH_4 concentration.

Figure 3-1: Trace gas sampling on the long-term study site on Samoylov Island.

CH_4 concentrations were determined with a gas chromatograph (Chrompack GC 9003) in the field laboratory (Hubberten et al., 2006). The instrument was equipped with a Poraplot Q (100/120 mesh, 20 m) capillary column, which operated with pure helium as carrier gas at a flow rate of 20 ml min^{-1}. CH_4 was analysed by a flame ionization detector. The injector/detector temperatures were set at 160 °C and the column oven at 80 °C. All gas sample analyses were done after calibration of the gas chromatograph with standard gases.

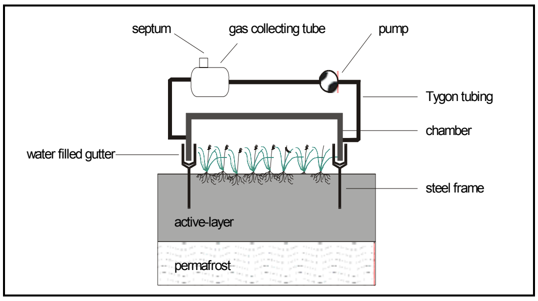

Figure 3-2: Schematic illustration of the methane emission measurement by closed chamber technique (left) and details of the set up during trace gas collection in the field (right).

The closed chamber measurements of CH_4 emission from the centre of a wet polygon tundra showed right from the start of soil thawing a relatively high CH_4 emission rate (> 10 mg h^{-1} m^{-2}) at the beginning of June, which increased with continuing thawing of the active layer. The highest CH_4 emission was observed during July with a rate of about 180 mg CH_4 d^{-1} m^{-2}. The detailed analysis of the data set is in progress.

3.3 Structure and Function of Microbial Communities Under Extreme Permafrost Conditions

Andreas Gattinger, Daria Morozova, Lars Heling and Dirk Wagner

3.3.1 Background

Previous samplings revealed comparatively high bacterial and archaeal biomasses as well as high methane production and oxidation rates in soil profiles from the rim and the centre of the polygons on Samoylov Island (Kobabe et al., 2004; Wagner et al., 2003; Wagner et al., 2005). The vertical distribution of (methanogenic) archaea could be related to the potential methane production, whereas the distribution of methanotrophic bacteria could be related to the potential methane oxidation measured in samples from the same soil depths (Wagner et al., 2005). These results led to the assumption of the existence of a well adapted soil microflora with psychrophilic properties, i.e. microbial activity at low temperatures.

During the expedition LENA 2004 samplings and experiments were performed with the following objectives:

- analysing small scale differences in methane fluxes and microbial community structure within different zones of a polygon.
- *in situ* cultivation of methanogenic archaea for isolating pure cultures
- determining *in situ* activity of cold adapted methanogenic archaea using stable isotope techniques
- estimating the border of salt tolerance of cold adapted methanogenic archaea
- quantification of methane oxidising activity under low temperature conditions

3.3.2 Field Experiments and Methods

The objectives of this expedition named above were divided into five different experiments, which were performed as following:

1st Experiment: Characterization of small-scale variability of microbial community structure and methane fluxes within different zones of a polygon

For this experiment a representative polygon was chosen with a morphologically significant formation of rim and centre structure. The polygon is located near the climate station and the research plot for long-term methane measurements. Three gradients from the rim towards the centre were defined and the grid points were measured with a laser theodolite (Elta 50 R) for subsequent geo referencing of the polygon (Figure 3-3).

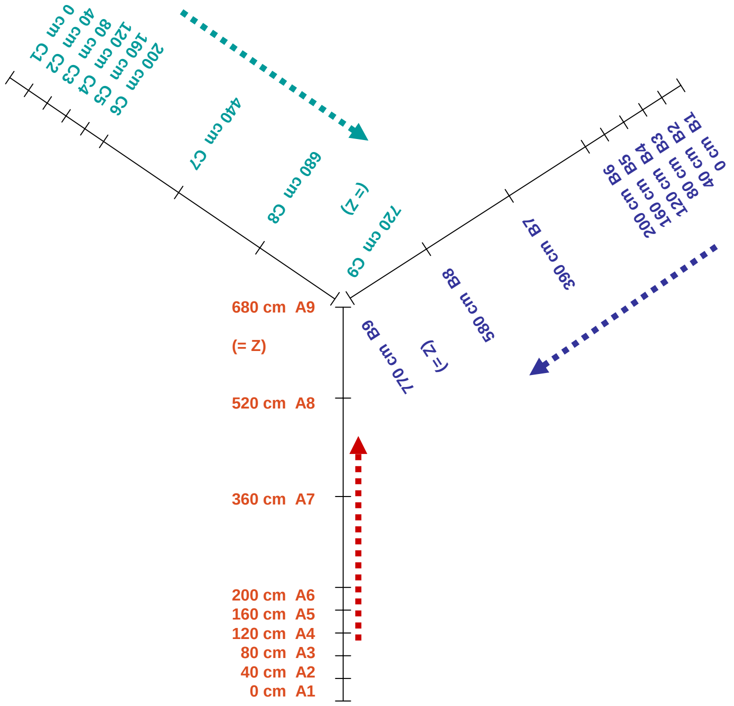

Figure 3-3: Alignment of the three sampling gradients in the polygon for investigations on small-scale heterogeneity. The arrows are showing from the three rim grid points (A1, B1, C1) towards the centre grid point Z.

Soil samples were taken on 22th July 2004 from each of the identified grid points until the frozen horizon with a maximum depth of 34 cm. If soil horizons could be identified macroscopically in a soil profile, this was divided into different depth horizons. In total 96 different soil samples were obtained and subsequently frozen for further investigations.

Samples will be investigated for microbial community structure using phenotypic (PLFA) and genotypic (DGGE) approaches with emphasis on organisms involved in the methane cycle (methanogens, methanotrophs; Gattinger et al., 2003; Wagner et al., 2005).

As the polygon from experiment 1 was selected as an appropriate sampling site for experiments 2, 3 and 4, two soil profiles were excavated on 23rd July 2004 from the polygon rim (Figure 3-4) and centre. The profiles were evaluated for humus content, texture and aggregation by means of field and lab (physico-chemical) methods to obtain a detailed description of the corresponding soil type.

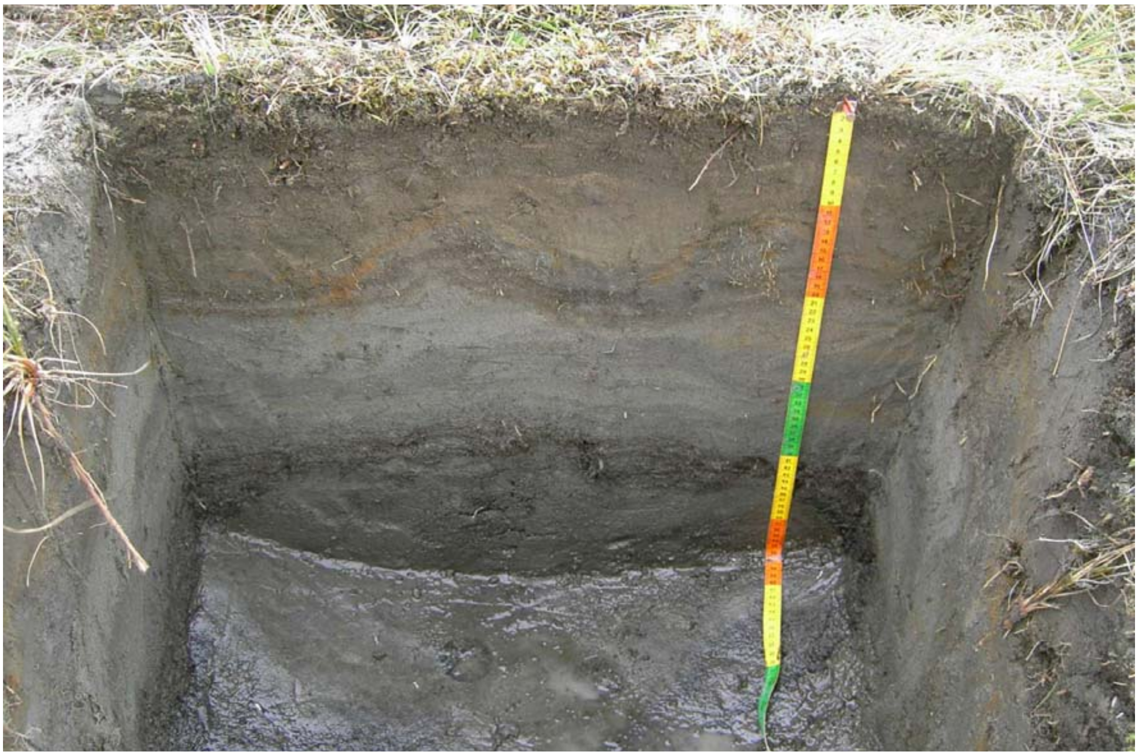

Figure 3-4: Soil profile from the polygon rim (located near grid point C1). The soil is classified as a *Typic Aquiturbel*.

2nd Experiment: In situ cultivation of methanogenic archaea for isolating pure cultures

On 6th July, 2004, *in situ* cultivation was commenced in soil zones of a polygon (described in experiment 1) and on 7th July, 2004 in the floodplains (“Nordplot”) of the Lena River. Therefore, a soil core (20 cm in diameter) covering the maximum thawing depth at that time was taken at each sampling point. Soil material from the lowest 33 mm of that core was used for *in situ* cultivation. The diffusion growth chambers were placed directly on frozen soil and were then covered again with the original soil material. Soil temperatures in the relevant zones were between +1 and +2°C.

- Sampling point 1 (in the centre of polygon, between grid point ZC and Z, thawing depth was 16 cm)
- Sampling point 2 (in the rim of polygon, near grid point C, thawing depth was 26 cm)
- Sampling point 3 (in the floodplains of Lena River, near *Nordplot*, thawing depth was 32 cm)

Teflon cylinders (33 mm height, 63 mm diameter, 103 cm^3 volume, Figure 3-5) were filled with the respective soil material and one of three different nutrient solutions based on acetate, methanol or acetate + methanol (Boone et al., 1989) were added. A polycarbonate filter (0.03 µm mesh size; OSMONICS Inc., USA) embedded between two gaze layers (0.5 mm mesh size) was placed on either side of the cylinder and fixed with a screwed washer.

Total *in situ* incubation time lasted from 6.7.04 and 7.7.04 to 24.7.04, and growth chambers were taken out of the soil. Prior to long distance transportation the polycarbonate filters were put into serum bottles containing the respective medium to enable transportation to the laboratory. Soil material was transferred into flasks which were subsequently flushed with N_2 to maintain anaerobic conditions.

Microscopic investigations are performed to check the filters for the existence and the morphology of microbial cells which determines which further steps will be taken.

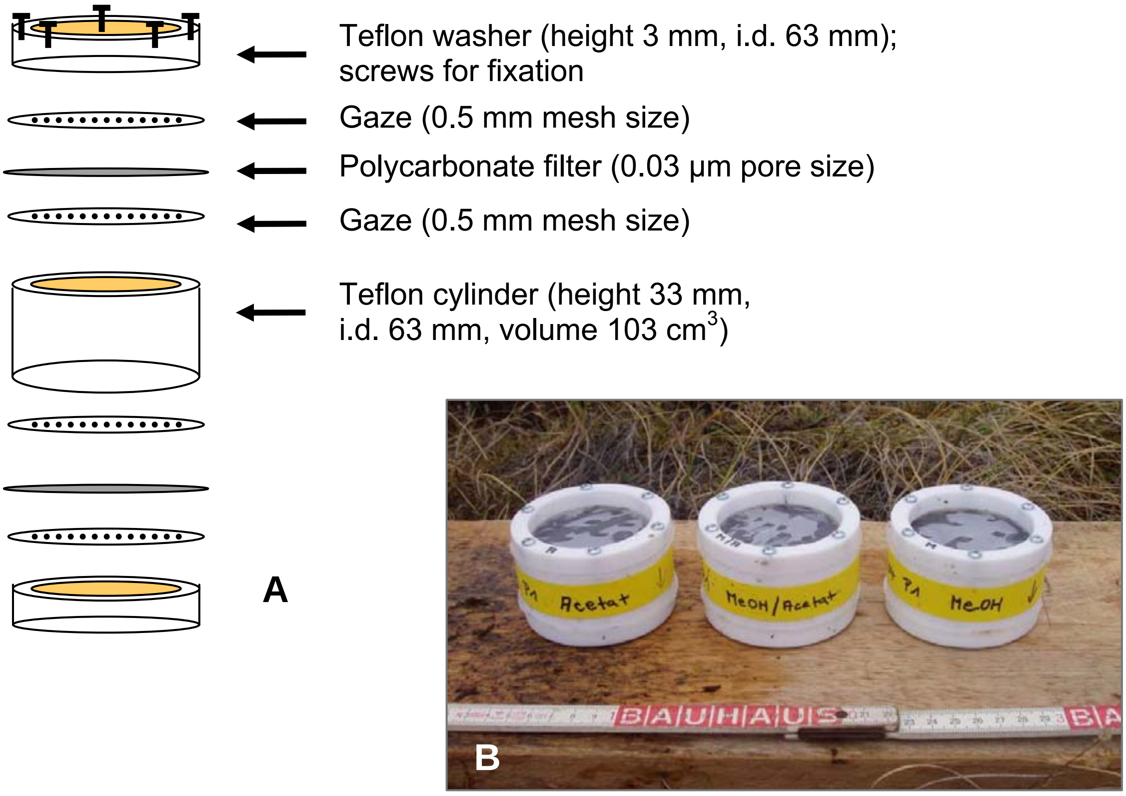

Figure 3-5: Schematic view of the diffusion growth chamber (A) and photograph of the prepared chambers before incubation under natural soil conditions (B).

3rd Experiment: Determination of the in situ activity of psychrophilic microorganisms in permafrost soil

This experiment aims at investigating microbial (methanogenic) activity under *in situ* conditions by linking microbial structure with function employing the stable isotope probing (SIP) assay.

The following hypotheses have been set up:

- methanogenic archaea are showing incorporation of (labelled) substrate carbon, hence these organisms are active at permafrost conditions (below -6°C) and are responsible for the methane detected in permafrost cores
- methanogenic archaea in permafrost soil are showing a preference rather for acetate than for methanol or H_2
- apart from archaea also some bacterial groups are showing activity at temperatures below -6°C
- there are no differences in the lipid biomarker composition among treatments, hence substrate addition does not change the overall microbial community structure

On 8th July, 2004, a soil core was taken from the wall of polygon (Experiment 1, grid point C, soil depth 59-89 cm). The thawing depth was 23 cm. The soil core was located at least 10 cm below the maximum thawing depth of the active layer. Frozen soil material was exposed to ambient temperature (11°C for 45 min) to ease homogenization and amendment with substrates. Dry matter content of the soil core was 54.3%.

Soil samples were incubated anaerobically for 17 days in the dark at temperatures between -6 and -8°C with three ^{13}C labelled substrates (CO_2, sodium acetate and methanol) in a 6 m deep ice cellar installed 400 m away from the study site on Samoylov Island. For each substrate control flasks were incubated with unlabelled substrates and a control experiment without any substrate additions was considered. Each treatment was carried out in duplicates. The time between the amendment with substrates and the placement of the sample flasks into the ice cellar was no more than 80 min.

CO_2 experiment

Samples (30 g fresh matter) were filled into 50 ml gastight Schott flasks (70 ml volume in total) containing a septum for gas injections. Flasks were flushed with N_2 (1 bar) for 30 s and 40 ml of gas were withdrawn with a syringe to ease additions of 4 ml $^{13}CO_2$ (99% ^{13}C, ISOTEC, Miamisburg, USA), 40 ml CO_2 (> 99.9% purity, MESSER, Krefeld, Germany) and 20 ml H_2 (> 99.9% purity, MESSER, Krefeld, Germany).

Acetate experiment

7 ml of a sodium acetate solution (10 mg ml^{-1}) in the labelled (2-^{13}C sodium acetate, 99%, Cambridge Isotope Laboratories, Cambridge, USA) or unlabelled form (Merck, Darmstadt, Germany), was added to the soil sample (80 g fresh matter) and the homogenized soil-acetate suspension was filled into 100 ml gastight Schott flasks. Prior to incubation the flasks were flushed with N_2 (1 bar) for 60 s.

Methanol experiment

7 ml of a 20 mM methanol solution in the labelled (^{13}C methanol, 99%, Cambridge Isotope Laboratories, USA,) or unlabelled form (Merck, Darmstadt, Germany), was added to the soil sample (60 g fresh matter) and the homogenized soil-methanol suspension was filled into 100 ml gastight Schott flasks. Prior to incubation the flasks were flushed with N_2 (1 bar) for 60 s.

Control experiment

Samples (30 g fresh matter) were filled into 100 ml gastight Schott flasks without any substrate additions. Prior to incubation the flasks were flushed with N_2 (1 bar) for 60 s.

Solutions:

1. unlabelled acetate diluting 5 ml of 1 M sodium acetate stock solution to 41 ml (= 10 mg ml^{-1})
2. labelled acetate dissolving 200 mg labelled sodium acetate in 20 ml demin. water (= 10 mg ml^{-1})
3. unlabelled methanol diluting 1 ml of 1 M methanol stock solution to 50 ml working solution (20 mM)
4. labelled methanol1 M stock solution: dissolving 0.32 g labelled MeOH in 10 ml demin. water 20 mM working solution: diluting 1 ml of methanol stock solution to 50 ml

The following soil chemical analyses will be performed at AWI: water content, pH, soil texture, C_{org}, C_t, $N_{t.}$

Concentration and $\delta^{13}C$ content of methane in the incubation flasks will be analysed with a GC device, coupled with a combustion furnace and an isotope ratio mass spectrometer (GC-C-IRMS).

Compound specific isotope analysis of phospholipids fatty acids (PLFA) and phospholipids etherlipids (PLEL) will be carried out (Gattinger et al., 2003;

Wagner et al., 2005). Neutral lipids and glycolipids will be stored for further analyses.

4th Experiment: Methanogenesis under different salt concentrations

The resistance of methanogenic archaea to different salt conditions was analyzed under *in situ* conditions. Soil samples were taken from the polygon rim and depression. Immediately after sampling fresh soil samples from the bottom of the active layer (polygon rim 30 g and polygon depression 20 g) were placed into 100 ml glass flask containing 20 or 40 ml salt solution, respectively. Salt solution contained NaCl (2.25 M), $CaCl_2$ (70 mM) and $MgCl_2$ (0.6 M). Selected concentrations of salt solution were used (0.1, 0.2, 0.3 and 0.4 M). Soil samples mixed with deionised water served as "positive" control. Also saturated NaCl solution (6 M) was selected. Flasks were closed gastight with a screw cap with septum, evacuated and flushed with pure N_2. Three replicates were used for each salt concentration. The prepared soil samples were incubated under *in situ* temperatures (from 0 to +2° C) in the bottom layer of the soil profile from which the samples had been taken (Figure 3-6). Growth was measured by methane production analysed by gas chromatography. Gas samples were taken every 24 h with a gastight syringe. The activity of methanogenic archaea was quantified from the linear increase in CH_4 concentration.

Figure 3-6: Preparation and *in situ* incubation of permafrost samples.

5th Experiment: Structure and function of methan-oxidizing communities

Methane emissions from permafrost soils are reduced by methanotrophic bacteria, oxidizing varying amounts of methane in the soil before it is released to the atmosphere. In order to characterize properties and population structure of these bacteria in wet tundra environments, representative soils of Samoylov Island were sampled. Analyses will include ecophysiological tests, biochemical determination of fatty acid biomarkers and molecular biological methods.

Investigations focused on the Late-Holocene river terrace with low-centred ice-wedge polygons. Soils of the depressed polygon centres and the elevated polygon rims were sampled once in June and twice in July 2004. In order to study spatial variability of methane oxidizing communities, three soil profiles of the polygon centres were sampled respectively. To facilitate a comparison of soil microbial data between organic and mineral soils, undisturbed soil cores for determination of soil bulk density were taken in addition.

At each sampling date soil temperatures, thaw depth and depth of water table were determined. Additionally the growth state of the dominant vascular plant *Carex aquatilis* was recorded, since wetland plants like *C. aquatilis* affect the activity of methane oxidizing bacteria by transporting oxygen into waterlogged parts of the soil. A further parameter influencing methane oxidizing activity is methane concentration in soil. It was determined by two methods: (a) In waterlogged polygon centres, soil pore water was collected with a syringe equipped with a steel capillary. These water samples were injected into glass tubes previously filled with enough NaCl to make up a saturated salt solution from the pore water. Methane was forced into the headspace by shaking the closed tubes and after that analysed by gas chromatography in the field. (b) In polygon rim soils that were not completely waterlogged, soils samples were added to a saturated NaCl solution in glass bottles. Methane again was forced from the soil solution into the headspace by shaking the closed bottles and could afterwards be analysed. For polygon centre soils this procedure was additionally applied in order to compare both methods.

Most of the samples for microbiological and biochemical investigations were immediately frozen after collection and transported frozen to Germany. Apart from that, a test portion of samples were transported at low but positive temperatures to check for the effect of freezing on the methane oxidizing activities. For molecular biological investigations (fluorescent-*in*-*situ*-hybridization), samples of a polygon centre profile were fixed with formaldehyde immediately after collection.

3.3.3 Preliminary Results

The analyses of the small-scale variability of microbial community structure and methane fluxes within different zones of a polygon (1^{st} experiment) is planned to carry out during PhD projects and master theses.

Analyses of the 2^{nd} experiment are ongoing.

In the 3^{rd} experiment methane could be determined in all samples independent from treatment. Significant ^{13}C enrichment was detected in all three substrate treatments, but first results show a substrate depending ^{13}C enrichment.

The 4^{th} experiment revealed high survival and adaptation of methanogens to high salinity under *in situ* conditions (Table 3-1). Methane formation under salt stress was different in both soils (Table 3-1, Figures 3-7 and 3-8). Methane production rates were determined in the soil samples from polygon rim, saturated with 0.1 M salt solution (0.197 nmol CH_4 h^{-1} g^{-1}) and 0.2 M salt solution (0.118 nmol CH_4 h^{-1} g^{-1}). Moreover, significant methane formation of methanogens was determined even in soil samples, incubated with saturated salt solution (Table 3-1, Figure 3-7). The potential activity of methanogens in these samples (0.009 nmol CH_4 h^{-1} g^{-1}) was only one order of magnitude lower in comparison with samples incubated with pure water (0.015 nmol CH_4 h^{-1} g^{-1}). The obtained results demonstrate that methanogenic archaea retained their viability even at high NaCl concentrations, although the salt content of thawed permafrost soils is very low (Boike *et al.,* 1998). However, increasing of salinity occurs in the soil pore water during seasonal freezing of the active layer during arctic winter season. Different factors could be taken into account to understand how methanogenic archaea are able to survive and even grow in saturated NaCl solution. For example, the presence of soil particles or some soil components is suspected to protect the microorganisms against high salt concentrations (Lapygina *et al.,* 2001).

In contrast, methane production rates in soil samples from the polygon depression appeared to decrease after 14 hours (Figure 3-8). The presented results show differences between the micro-relief elements of the investigated polygon (elevated rim and depressed centre) with regard to CH_4 formation, salinity adaptation of methanogenic archaea and soil characteristics.

Table 3-1: Methane formation in soil samples exposed to different salinities. Means ± standard error, r^2 = linear increase coefficient, n=3.

Salt solution concentration [M]	**Methane production [nmol h^{-1} g^{-1}]**			
	Polygon rim *(Glacic Aquiturbel)*		Polygon centre *(Typic Historthel)*	
	In situ, 18-23 cm, + 2°C	r^2	*In situ*, 7-12 cm, + 2°C	r^2
0 (control)	0.02±0.004	0.74	1.16±0.05	0.83
0.1	0.2±0.02	0.93	0.05±0.03	0.65
0.2	0.12±0.09	0.85	0.01±0.06	0.62
0.3	0.07±0.01	0.83	0.21±0.03	0.52
0.4	0.05±0.03	0.97	0.09±0.02	0.63
6 (saturated)	0.01±0.0	0.82	0.08±0.03	0.58

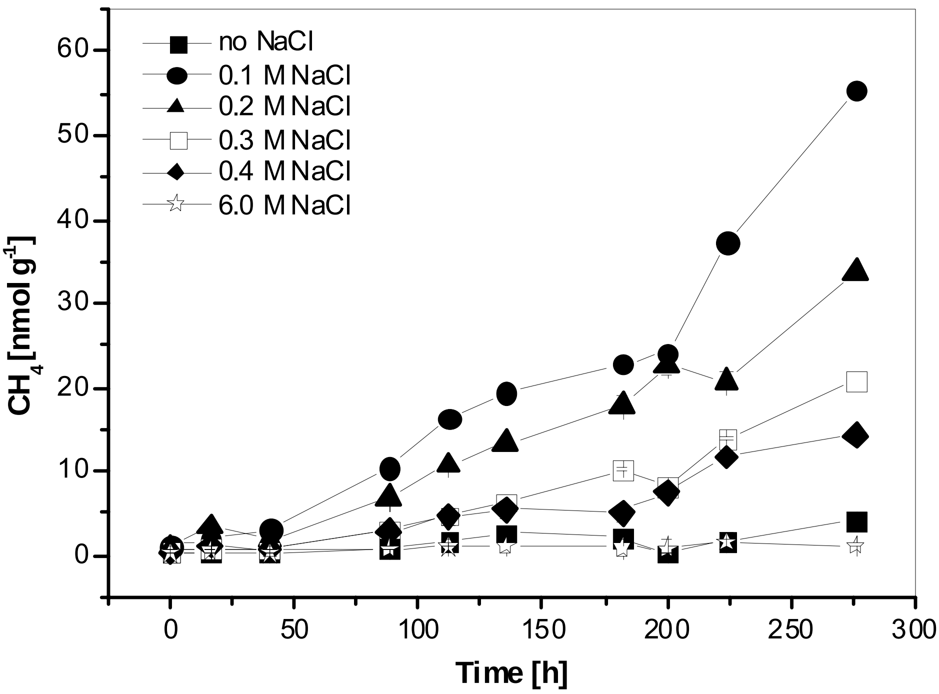

Figure 3-7: Methane production by methanogenic archaea in polygon rim soils incubated with varying salt concentrations under *in situ* conditions (+2° C).

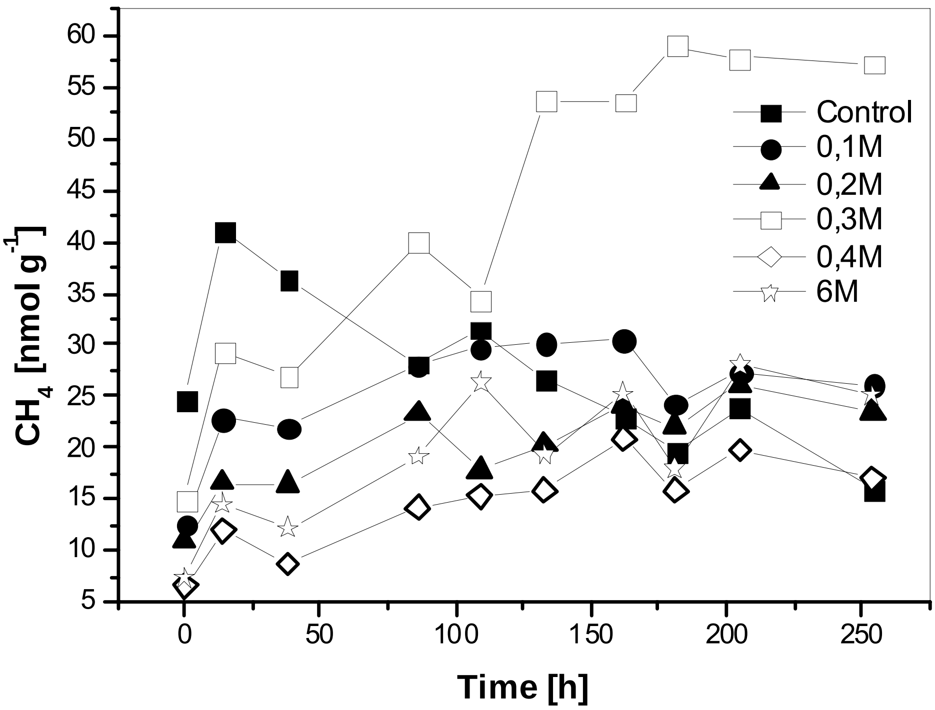

Figure 3-8: Methane production by methanogenic archaea in polygon depression soils incubated with varying salt concentrations under *in situ* conditions (+2° C).

3.4 Micrometeorological Measurements of Energy, Water, and Carbon Exchange between Arctic Tundra and the Atmosphere

Christian Wille, Lars Heling and Günter Stoof

3.4.1 Introduction and Experimental Set-up

The micrometeorological measurements of the previous two years were continued during the 2004 campaign. They comprised the determination of the turbulent fluxes of energy, water vapour, carbon dioxide and methane from the ground into the atmosphere using the eddy covariance technique, as well as the measurement of supporting meteorological and soil-physical parameters. The measurements lasted from May 28 through July 20, and hence included the period from late winter with temperatures well below 0°C through to midsummer when the depth of the active layer had reached about half of the average maximum thaw depth. The purpose of the study was:

- to characterise the seasonal progression of the exchange fluxes of energy, water, and carbon, with a focus on the thaw period,
- to assess the energy partitioning at the investigated tundra site,
- to quantify the exchange fluxes of water, carbon dioxide and methane on the landscape scale,
- to investigate the interactions between the energy and water balance of polygonal tundra and the carbon exchange processes between permafrost soils, tundra vegetation, and the atmosphere,
- to analyze the regulation of the energy and matter fluxes by climatic forcing.

The investigation site and the technical set-up of the eddy covariance system (ECS) and supporting measurements were identical to 2003. For a detailed description see Kutzbach et al. (2004).

3.4.2 The Observation Period 2004

Figure 3-9 shows two basic parameters describing the wind conditions during the 2004 measurement campaign. The predominant wind direction was east, with winds from the sector 70° - 110° occurring about 27% of the measurement period. This is a marked difference to 2003, where three different predominant wind directions (SSE, ENE, WSW) where observed. Winds with directions not acceptable for flux calculations due to disturbance from the generator (230°-270°) occurred about 4.8% of the time, which was far less frequent than in 2003 (13.5%). Overall mean wind speed was 4.7 ms^{-1} and the maximum half-hour mean wind speed was 12.3 ms^{-1}. Strongest winds tended to come from easterly and westerly directions, while light winds came from SSW and NO.

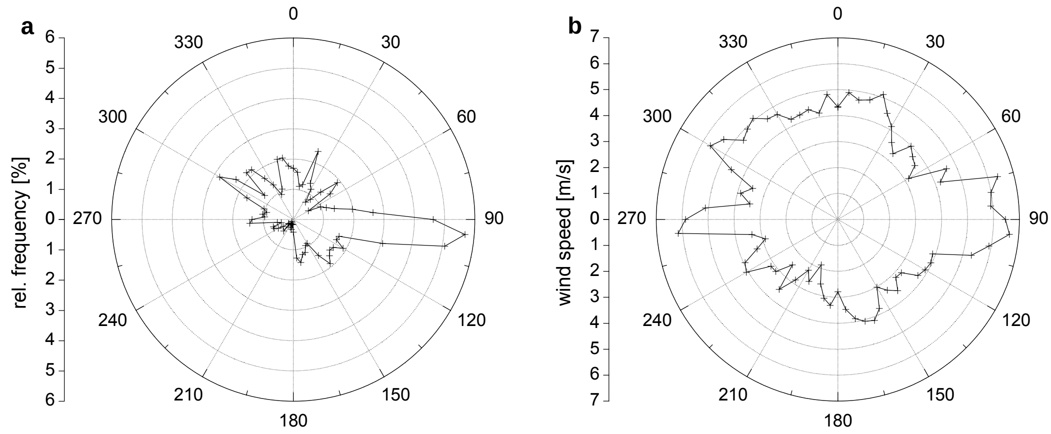

Figure 3-9: Summarized wind data from Samoylov Island during the micrometeorological study period, May 28 to July 20, 2004. – **a** frequency of occurrence of wind from specific direction, **b** mean wind speed versus wind direction.

The meteorological conditions on Samoylov Island during the study period 2004 are given in Figure 3-10. The air temperature and net radiation show the usual diurnal pattern and also illustrate the seasonal progression from late winter to summer. The mean daily net radiation increased from about 20 W m^{-2} at the end of May to about 180 W m^{-2} at the end of July. The mean daily air temperature ranged from -6°C to +13°C in the course of the study period. Two strong rainfall events occurred on June 8 and July 8-9 respectively. Overall liquid precipitation during the study period was 63 mm. The rainfall event on July 8 was particularly strong with more than 38 mm of rain within 24 hours. The snow height was measured automatically by the meteorology station in the depression of a low center polygon. At the beginning of the study period, the snow height was about 40 cm. Due to repeated snow fall at the end of May and beginning of June, and due to the low air temperature, which was almost constantly below 0°C until June 7, the snow melt initially progressed very slowly. A more rapid decrease of the snow height started after June 8, when a significant rain event caused a strong melting and deterioration of the snow cover albedo, and the air temperature more regularly reached values above 0°C. Generally, with a persistent snow cover, and night time air temperature close to or below 0°C occurring well into June, the spring and hence the vegetation period started very late in 2004.

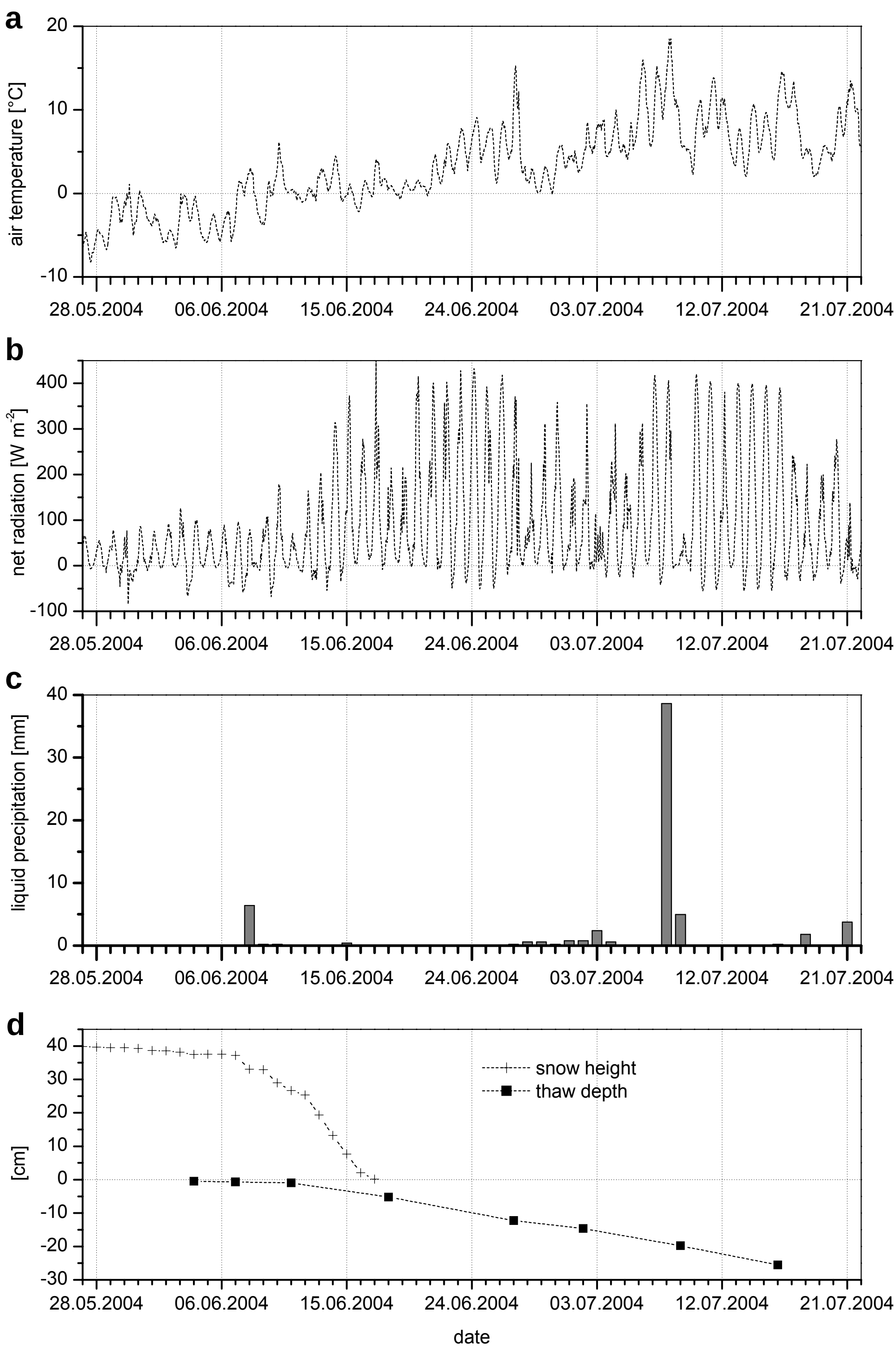

Figure 3-10: Meteorological data from Samoylov Island during the study period May 28 to July 20, 2004. – **a** air temperature (at 2 m height), **b** net radiation, **c** precipitation (rain), **d** snow height and soil thaw depth. **a**, **b**, **c** and snow height were measured by the meteorological station on Samoylov Island, soil thaw depth is the average thaw depth of 150 measurement positions at the active layer monitoring site.

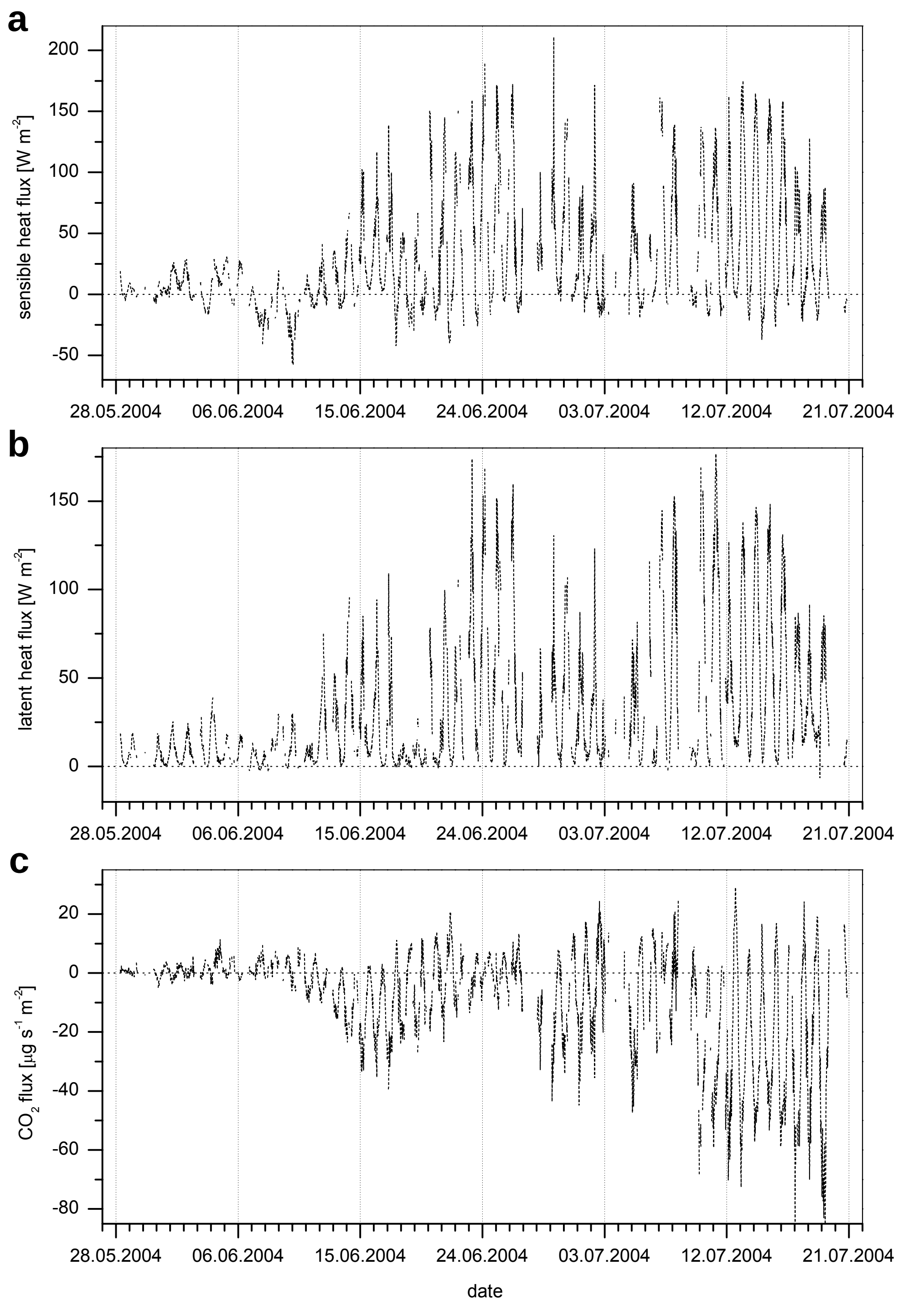

Figure 3-11: Turbulent flux densities during the study period May 28 through July 20, 2004. – **a** sensible heat flux, **b** latent heat flux, **c** carbon dioxide flux.

The turbulent fluxes of sensible and latent heat and of carbon dioxide measured during the study period 2004 are presented in Figure 3-11. The data series show clear diurnal and seasonal trends. Up until the middle of June, the sensible heat flux was below +50 W m^{-2} with frequent negative flux values up to -50 W m^{-2} during day and night time. After this, the sensible heat flux increased to reach maximum daytime values of typically +180 W m^{-2} from around the end of June; negative values occurred only at night time. Similarly, the latent heat flux showed only low values of up to +30 W m^{-2} until June 11, with a marked increase after this date and maximum values of up to +175 W m^{-2} from around the last third of June. Towards the end of the 2004 campaign, both sensible and latent heat flux decreased slightly. The influence of the driving and limiting forces, i.e. net radiation and snow coverage is clearly visible. The CO_2 flux showed a more varying behaviour than the heat fluxes. Only a small diurnal trend was visible before June 11, with mainly positive flux values. After the melting of the snow cover, photosynthesis started and clearly dominated the respiration of vegetation and soils so that nearly no positive flux values were observed. As the thawing of the soil progressed, the respiration gained importance and the flux values oscillated between positive values of up to 20 µg s^{-1} m^{-2} at night time and negative values of up to -80 µg s^{-1} m^{-2} during daytime. Here also the influence of the driving and limiting forces, net radiation, snow coverage and soil thaw depth is visible. The measurements of methane flux were disturbed by technical problems, hence no time series of this data can be displayed. Further work will go into the analysis and interpretation of this data.

3.4.3 Closed Chamber Emission Experiments for Determining the CO_2 Balance

In the course of data acquisition for a diploma thesis at the Department of Soil Science at the University of Hamburg, diverse closed chamber emission experiments were conducted to define the CO_2-balance of exemplary zones in the study areas. These experiments accompanied analyses of the Eddy-Covariance-System. A comparison of the results of conventional closed chamber emission experiments and those of the eddy covariance technique are the goals of this diploma thesis. Furthermore, it is attempted to differentiate the CO_2-balance defining factors, which are microbial soil respiration and plant respiration.

A total of ten measurement areas were analysed in the sampling procedure which was conducted from 13.06.04 to 24.07.04. These study areas were positioned in order to survey a variety of morphologically definable surface units of measure.

As well as drawing samples on polygon rims, slopes and centres and in areas of degenerated low centre polygons, attention was also given to categories which do not correspond with the former. This refers to locations directly above cracks.

At least two measurement cycles were conducted daily. These had to combine at least three study areas each. For the purposes of an improved comparability of these cycles it was aspired to measure at the same time of day. These measurements were supplemented by one diurnal course. In the course of this study measures were conducted on six areas for 24 hours with a period of six hours.

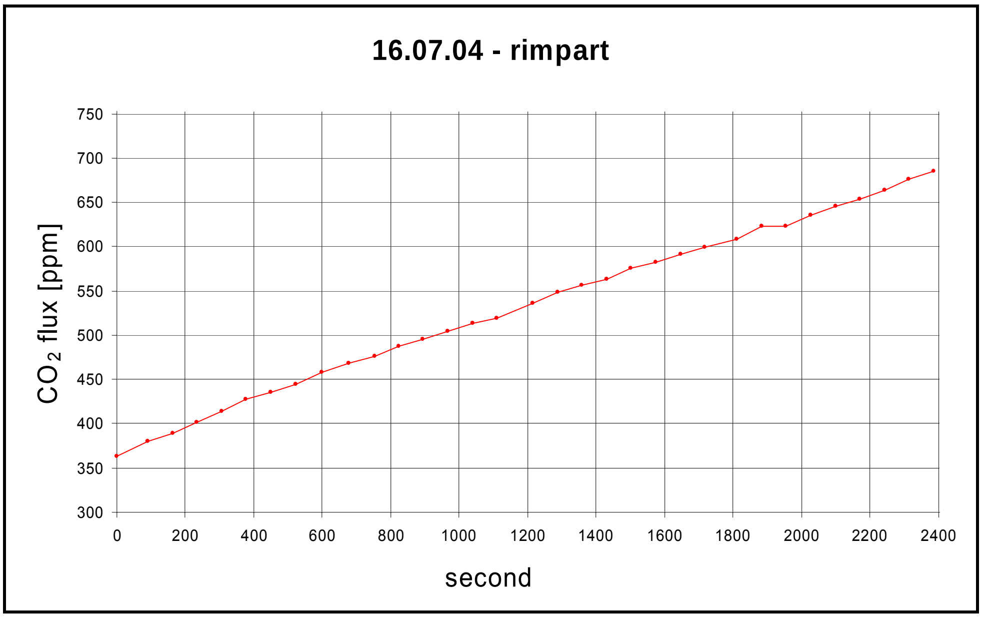

Figure 3-12: Example of concentration changes of carbon dioxide from the 16.07.04-rim. The data collection started at 14:02h local time.

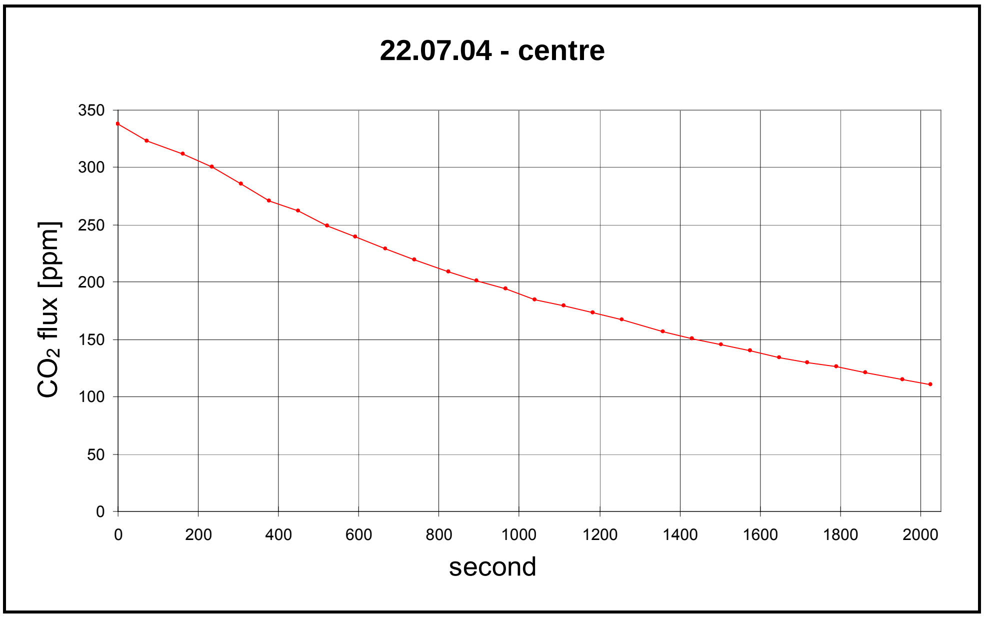

Figure 3-13: Example of concentration changes of carbon dioxide from the 22.07.04-centre. The data collection started at 22:14h local time.

Based on an ambient air sample, measurements were taken every 10 minutes within a measurement period of 30 minutes. The number of primary samples for each measurement should verify the identification of linear concentration changes. The calculation of the CO_2 fluxes is a result of the linear regression analysis in the changes of gas concentration through time. All samples were transferred into gas tubes for storage, transport and later analyses. At the end of the measurement campaign 550 samples are available.

Besides the described sample taking 38 data records were surveyed with a photoacustic gas analyser. These will expand into this report with two examples. The Figure 3-12 shows changes of CO_2 concentration at a rim measurement area with a positive CO_2 flux of 53.44 mg m^{-2} h^{-1}. As an opposite to the first example the Figure 3-13 shows concentration changes within the centre of a polygon with a negative CO_2 flux of 69.48 mg m^{-2} h^{-1}. All included data and resultant gas fluxes are related to experiment configurations with transparent chambers.

3.5 Energy and Water Budget of Permafrost Soils – Long Time Meteorology and Soil Survey Station on Samoylov Island

Christian Wille and Julia Boike[§]

The permanent meteorology and soil survey station on Samoylov Island is situated about 200 meters northeast of the Lena Delta reserve station building on a Holocene river terrace which is characterized by polygonal tundra with raised, dry polygon rims and low, wet polygon centers. The station was set up during the Lena 2002 expedition and put into operation on 24.08.2002. For detailed information about the setup of the measurement stations see Grigoriev et al. (2003) and Schirrmeister et al. (2004).

The data recorded by the measurement station and the sensors used are given in Table 3-2. Meteorological data (Pos. 1-5 in Table 3-2) was sampled every 20 seconds and hourly averages were stored. Up until August 13, 2003, soil data (Pos. 6-10 in Table 3-2) was sampled and stored every hour. After August 13, 2003, soil temperature and heat flux was measured every 10 minutes and hourly averages were stored while snow height, electrical conductivity and volumetric water content were sampled and stored every hour as before.

During the Expedition Lena 2004 no changes were made to the measurement station. The meteorological sensors, the rain gauge and the snow height sensor were cleaned and checked for proper operation. The station collected data continuously from July 13, 2003 until the end of the 2004 measurement campaign, July 26, 2004. Figure 3-14 shows selected data from the measurement stations to illustrate the quality of the data series. The raw data will be transferred to an SQL database which is hosted by the Institute of Environmental Physics at the University of Heidelberg and subsequently analyzed.

[§] not participating in the expedition LENA 2004

Table 3-2: Data and sensors of permanent measurement station.

Pos.	Data Measured	Sensor Type
1	Air Temperature and Relative Humidity (0.5 and 2.0 m above ground)	Rotronic Meßgeräte GmbH Meteorological Probe MP103A
2	Wind Speed & Direction (3.0 m above ground)	R M Young Company Anemometer 05103
3	Net Radiation (1.35 m above ground)	Kipp & Zonen B.V. Net Radiometer NR-Lite
4	Long wave Radiation (1.28 m above ground)	Kipp & Zonen B.V. Pyrgeometer CG1
5	Precipitation (liquid, i.e. Rain) (0.3 m above ground)	R M Young Company Tipping Bucket Rain Gauge 52203
6	Snow Height (in centre of polygon)	Campbell Scientific Ltd. Sonic Ranging Sensor SR 50
7	Soil Temperature (4 measuring profiles)	Campbell Scientific Ltd. Thermistor Soil Temperature Probe 107
8	Soil Bulk Electrical Conductivity (3 measurement profiles)	Campbell Scientific Ltd. TDR 100, Probe CS605
9	Soil Volumetric Water Content (3 measurement profiles)	Campbell Scientific Ltd. TDR 100, Probe CS605
10	Heat Flux out of / into Soil (2 measurement points)	Hukseflux Thermal Sensors Heat Flux Sensor HFP01

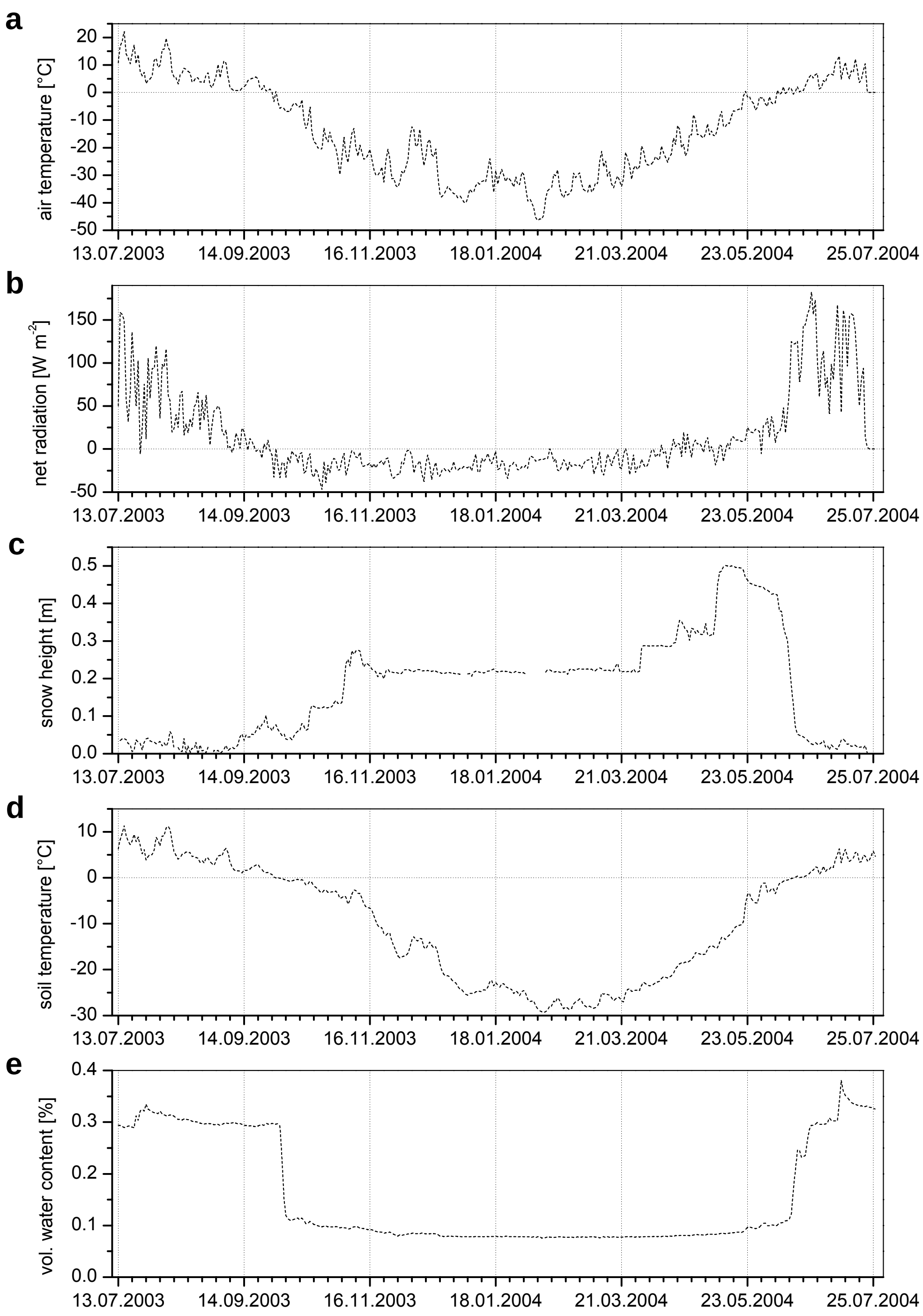

Figure 3-14: Selected daily averages of meteorology and soil data from survey stations on Samoylov Island for the period July 13, 2003 – July 26, 2004. – **a** air temperature (at 2 m height), **b** net radiation, **c** snow height, **d** soil temperature, **e** volumetric water content (**d** and **e** are taken from the polygon rim profile, 5 cm below the soil surface).

In order to describe the processes involved in the thawing of the snow cover more thoroughly, snow profiles in three different polygons were sampled and described on several occasions. The profile pits were dug in the center of low center polygons, the texture and grain size of the snow was described, photographs taken, and temperature profiles of the snow cover were measured. Snow samples of different snow horizons were taken with a corer of 0.5 liter volume. The weight of the snow samples was measured and the average density of the snow profile calculated. A summary of the data is given in Table 3-3. In polygon 1 and 2, the average snow density shows a strong increase between May 20 and May 31. On May 22 the air temperature for the first time in 2004 rose above 0°C and reached nearly +2°C. This caused melt water to infiltrate into the snow and increase the density. The decreased snow density in polygon 2 on May 22 seems to indicate a problem with the sampling process or the storage of samples.

Table 3-3: Snow height and average snow density of investigated snow profiles.

Date	**Polygon 1**		**Polygon 2**		**Polygon 3**	
	snow height (cm)	avg. density (g cm^{-3})	snow height (cm)	avg. density (g cm^{-3})	snow height (cm)	Avg. density (g cm^{-3})
20.05.04	40	250.5	43	262.5	--	--
22.05.04	29	291.7	31	237.1	--	--
24.05.04	--	--	--	--	50	372.1
31.05.04	--	--	--	--	51	394.6
03.06.04	--	--	--	--	48	392.6

Manual measurements of the snow height were carried out in a low center polygon about 60 meters east of the permanent measurement stations. Along a transect through the polygon, 25 locations were sampled every 2-4 days. The average snow height from these measurements is displayed in Figure 3-15, together with the automatic snow height measurements of the soil survey station. The manual measurements give a different picture of the thaw process because the incorporate different parts of the polygon. The thaw process seems to progress slowest in the polygon center and fastest on the raised polygon rims.

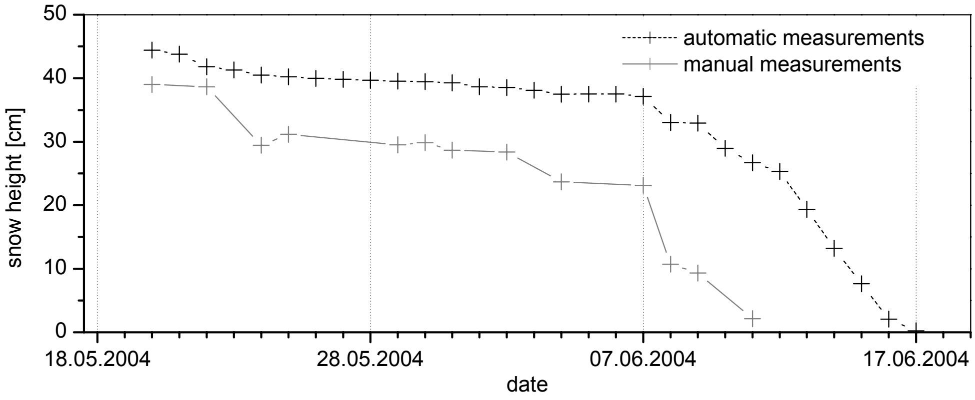

Figure 3-15: Automated and manual snow height measurements.

3.6 Seasonal Progression of Active-layer Thickness Dependent on Microrelief

Günter Stoof and Christian Wille

In 2002, an active-layer thickness monitoring program was started on Samoylov Island. An investigation site of 28 m x 18 m was established on the area of a typical low-centre polygon in the vicinity of the permanent meteorological and soil survey station. 150 measurement points were mapped out in a regular grid of approximately 2 m x 2 m. The measurement points were grouped in 5 classes according to their situation within the micro relief and their vegetation cover. For a detailed description of the investigation site and a characterization of the classes see Kutzbach et al. (2004). In 2004, measurements were conducted from June 4 to July 16 (2003: June 15 – October 4; 2002: June 10 – August 30). In addition, a measurement of the snow height was carried out on May 25. Table 3-4 shows the average snow height of the 5 different classes on May 25 and the percentage snow coverage which was recorded during the subsequent thaw depth measurements.

Table 3-4: Snow height and percentage snow coverage during the 2004 campaign.

class	fraction	snow depth [cm]	snow coverage [%]			
		25.05.04	04.06.04	07.06.04	11.06.04	18.06.04
1	26.0 %	40.7	100	100	90	0
2	16.6 %	32.8	100	96	52	0
3	22.0 %	8.8	42	36	3	0
4	31.3 %	23.5	87	83	17	0
5	4.0 %	25.5	83	83	67	17

In 2004 the snow cover persisted until about the middle of June whereas snow height measurements of the soil survey station showed that the snow cover in the polygon center was melted down around May 20 in 2003. The reason for this are the low air temperatures in May and June 2004. For a summary of the monthly average air temperatures see Table 3-5.

Table 3-5: Monthly air temperature at two meters height from Stolb met station.

month	average air temperature [°C]		
	2002	2003	2004
May	-8.5	-4.8	-7.6
June	6.9	3.5	1.1
July 1-21	9.6	11.8	7.8

The seasonal progression of the mean active-layer thickness during the expeditions of 2002 – 2004 is presented in Figure 3-16. Despite the late start of the thaw process, by the end of the 2004 campaign the overall average thaw depth had reached values quite close to those recorded in the previous years.

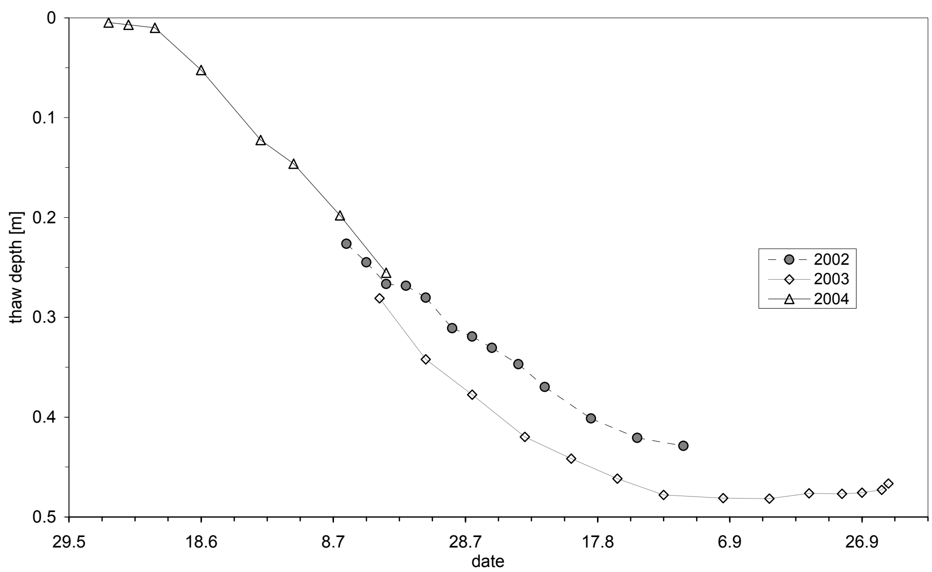

Figure 3-16: Seasonal progression of active-layer thickness in 2002, 2003 and 2004. Values are means of all 150 measurement points.

The influence of the micro relief on the thaw depth is shown in Figure 3-17. At the beginning of the thaw process in 2004, differences between the classes were small compared to differences during the late stage of the thaw process in 2003. However, there were great differences in active layer thickness between the years 2003 and 2004. The data needs to be discussed in more detail taking meteorological data series (radiation, temperature, precipitation) into consideration.

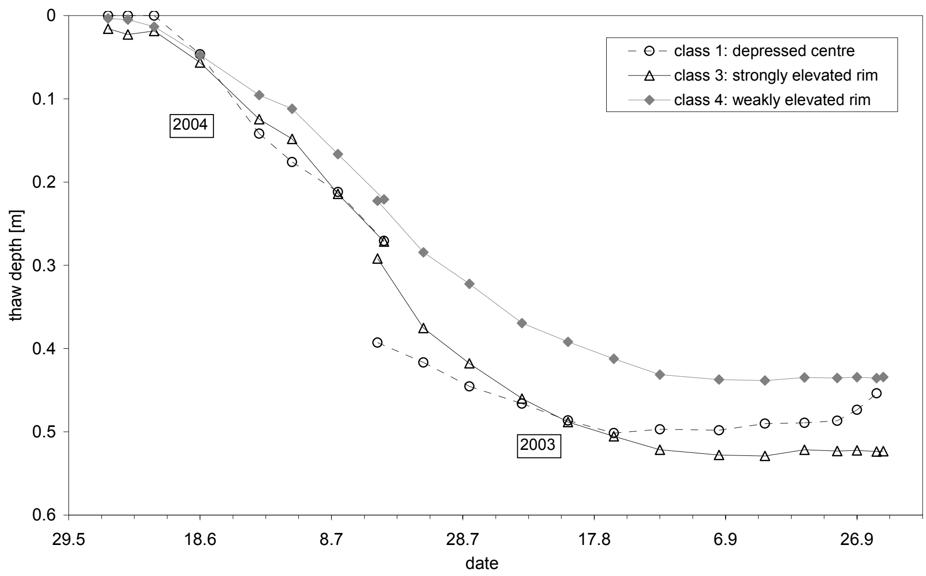

Figure 3-17: Seasonal progression of active-layer thickness in 2003 and 2004 differentiated by situation within the microrelief. Values are class means (class 1: *N* = 39, class 3: *N* = 33, class 4: *N* = 47).

3.7 Hydrobiological Investigations in the Lena Delta

Ekatarina N. Abramova and Irina Vishnyakova[§]

3.7.1 Introduction

Data on the seasonal-interannual variations of the zooplankton species composition and abundance in the modern high-latitude Arctic water biocoenoses are insufficient so far and information on the processes regulating population dynamics and community structure of the pelagic organisms in different seasons of the year are lacking.

The monitoring zooplankton investigations were continued in the Lena Delta in summer 2004. New data on population structure, ecology, biology, abundance and biomass fluctuations of the fresh-water pelagic organisms were obtained, which demonstrate the relationship between the unusually cold conditions of the last summer and zooplankton community dynamics. For understanding peculiarities of modern zooplankton assemblages inhabited different types of water pools and the history of its formation, we paid attention to the detailed taxonomic, historical-faunistic and ecological analyses of zooplankton species from the different lakes. Also some data of nutrients contain and seasonal dynamic of the primary production as a changing of chlorophyll A concentration in the channels and lakes and its dependence on Lena River waters influence and temperature conditions were received.

Our investigations focused on:

- the analyses of the seasonal processes in zooplankton communities in the different types of the water pools;
- the temperature and life cycle dependences for the common Copepoda and Cladocera species
- the comparison of the species composition in the different water basins with the help of species similarity indices (Jaccard, 1901; Simpson, 1949);
- the detail taxonomical analyses of Copepoda species for determination of the paleo-, meso- and neolimnic complexes;
- the chlorophyll A concentration characterizing the primary production in the water basins;
- the collecting of modern and recent Ostracoda and Mollusca from the benthic samples and cores.

[§] not participating in the expedition LENA 2004

3.7.2 Material and Methods

Thirty seven phytoplankton, sixty zooplankton and five benthic samples were collected from the same water pools like in the previous years (channels, terrace lakes, small and big thermokarst lakes, alas) in the southern part of the Lena Delta (Samoylov and Buor-Khaya islands) during the German-Russian “Lena-Delta-2004” expedition. As a earlier, sampling of zooplankton was performed by filtering of 100 liters of water through a 100-μm mesh size net with periodicity of 3 - 5 days and fixation with 70% alcohol or 4% borax-buffered formalin. Samples were analyzed in a Bogorov chamber under a binocular microscope WESSEX WSP2 and the abundance of organisms was calculated. Almost all adult organisms were determined to species level. Juvenile copepods were separated into copepodite stages and identified to species/genus level. Detailed taxonomic analysis and pictures of the common and rear zooplankton species were made using Olympus SZX9 and Olympus BX60 microscopes with the adjusted camera and computer program “Analysis” in the Otto Schmidt Laboratory in St.-Petersburg. Based on the strong taxonomic analyses, and using the number of asymmetric body parts of *Copepoda* species as an indirect criterion of specialization (Brodskii et al., 1983), to carry out historical-faunistic analysis of the modern freshwater fauna in the Lena Delta. Pelagic assemblages inhabited the different types of the water pools located at different regions and geomorphological levels in delta were compared with the help of Jaccard and Simpson indices and with using the data collected in the previous two years (Jaccard, 1901; Simpson, 1949).

One liter of water was filtrated thought special filters for estimation of chlorophyll A concentration in the lakes and channel. These samples were analyzed on the spectrophotometer "SPECORD 200" and fluorimeter TD - 700 in the Otto Schmidt Laboratory. Water samples were collected from polygons, channels, terrace lakes for investigation the nutrients contain. The data on nutrients composition and concentration were obtained using the automatic analyzer SCALAR in the OSL.

Live ostracods were collected from planktic and benthic samples from small thermokarst lakes and a terrace lake on Samoylov Island for the species identification. Also, two sediment cores, one from alas on the Buor-Khaya Island (35 cm) and another one from a small thermokarst lake on the Samoylov Island (25 cm) were collected during the expedition for detailed study of recent and fossil ostracods and molluscs.

3.7.3 Preliminary Results

Species composition and peculiarities of the seasonal dynamic of zooplankton abundance

The same species composition was observed in the zooplankton assemblages of the different water pools in the region of our investigation like in the previous years (Abramova, 2002). A relatively low species diversity was discovered in the small polygonal lakes where the taxonomic composition and abundance were dominated by the *Copepoda* and *Cladocera* species (up to 99% of the average total abundance, Figure 3-18) and highest number of species was found in the Olenekskaya channel and flood-plain lakes of the first terrace, where *Rotatoria* and *Copepoda* species (Figure 3-19) usually prevail in the pelagic community.

Like in the previous years the highest zooplankton diversity and abundance was observed in the water pools located on the first terrace, which regular influenced by river waters in the period of spring runoff of the Lena River (Abramova et al., 2003). River waters bring in nutrients, phytoplankton and bacteria, thus providing a significant contribution to the production of particulate food for zooplankton. The highest silicate and chlorophyll A concentration were fixated in the Olenekskaya channel and in the flood-plain lake (Tables 3-6 and 3-7). In general, summer pelagic fauna in the region of investigation was comparatively abundant. But, different patterns of the seasonal dynamic of zooplankton abundance emerge on the polygonal lakes in relation to the specific environmental conditions in spring and summer 2004. In July of this year the water temperature in the different lakes was on average 4 - 5 lower to compare with previous years. If in summer 2002 and 2003 the maximums of total abundance was connected with reproduction of *Cladocera* and *Calanoida* species and had place in the beginning and in the end of July. In summer 2004 the abundance of both groups of planktonic organisms increased only once, in the end of July. The late reproduction was also observed in zooplankton community of the flood-plain and big thermokarst lakes on the Samoylov Island.

Comparison of pelagic fauna various lake types

Indexes of Jaccard (Kj) and Simpson (Ks) show high degree of similarity in zooplankton of polygonal ponds situated in different parts and on different geomorphological levels of the delta. The homogeny in distribution of the some pelagic species is seemingly related to wind-induced dispersion of inactive stages of the pelagic organisms after drying of polygonal ponds. The index of the species similarity (Kj) varied between 35 and 51 % while the index of degree of inclusion the most poor into the most richness community (Ks) varied between 56 and 86 %. Zooplankton of flood-plain lakes is less homogenous, Kj ranged from 30 to 37 %, Ks – from 48 to 56 %. Remarkable difference in the species composition is typical for large thermokarst lakes of the first terrace as well as in alas lakes of the third terrace. In first case Kj doesn’t exceed 17 % with Ks 50 %, in the second case indexes are 14 % and 41% accordingly. When compare the pelagic fauna of the different-typed lakes situated on two terraces we can see that the highest degree of specific similarity (Kj about 25%) occur in polygonal and flood-plain lakes of the first terrace (Tit-Ary, Samoylov Islands). Higher difference occur in species composition of zooplankton communities when compare big thermokarst lakes and alasses both situated on third terrace (Buor-Khaya and America-Khaya Islands) for which the index of similarity was less than 14 %.

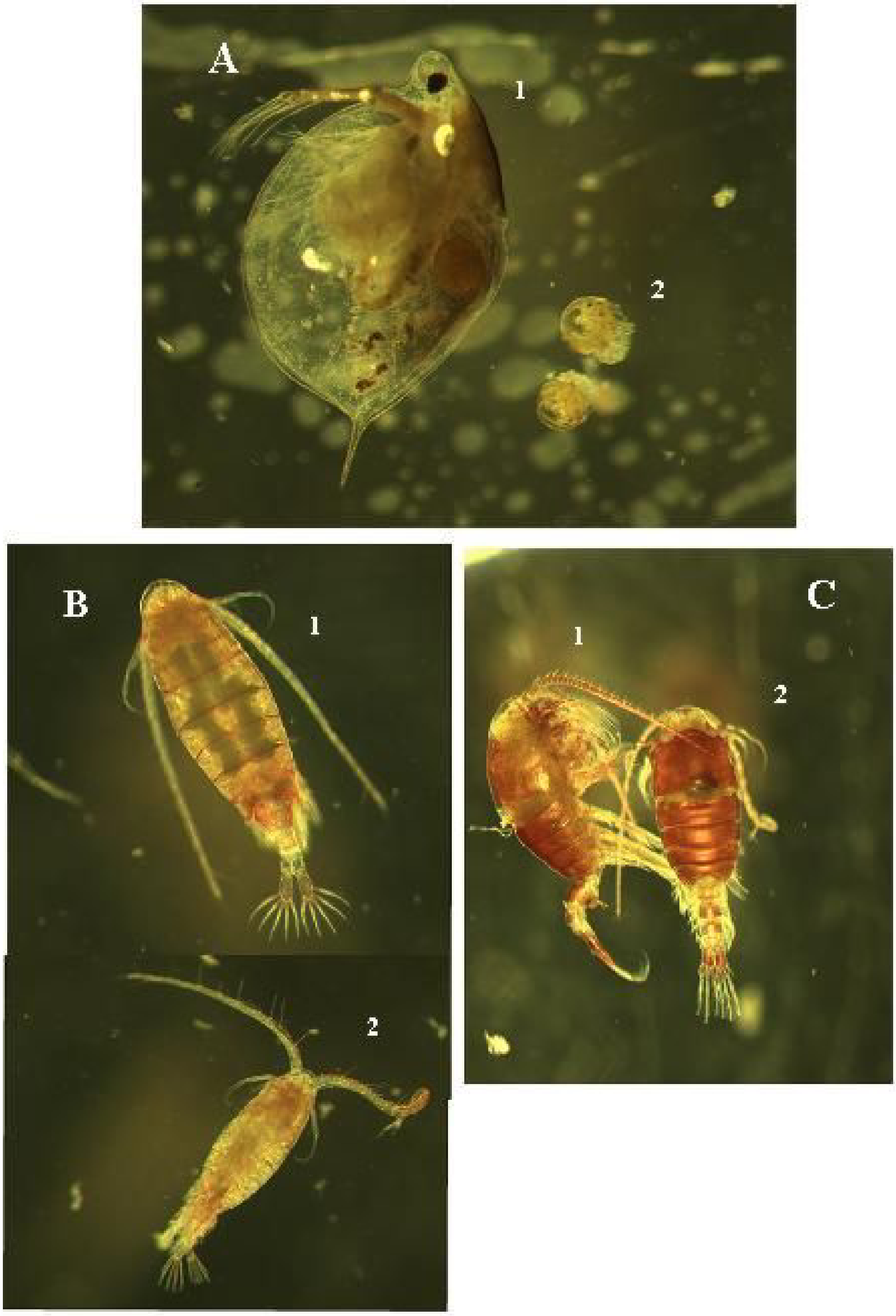

Figure 3-18: Zooplankton from a small polygonal lake (*Copepoda* and *Cladocera* species).

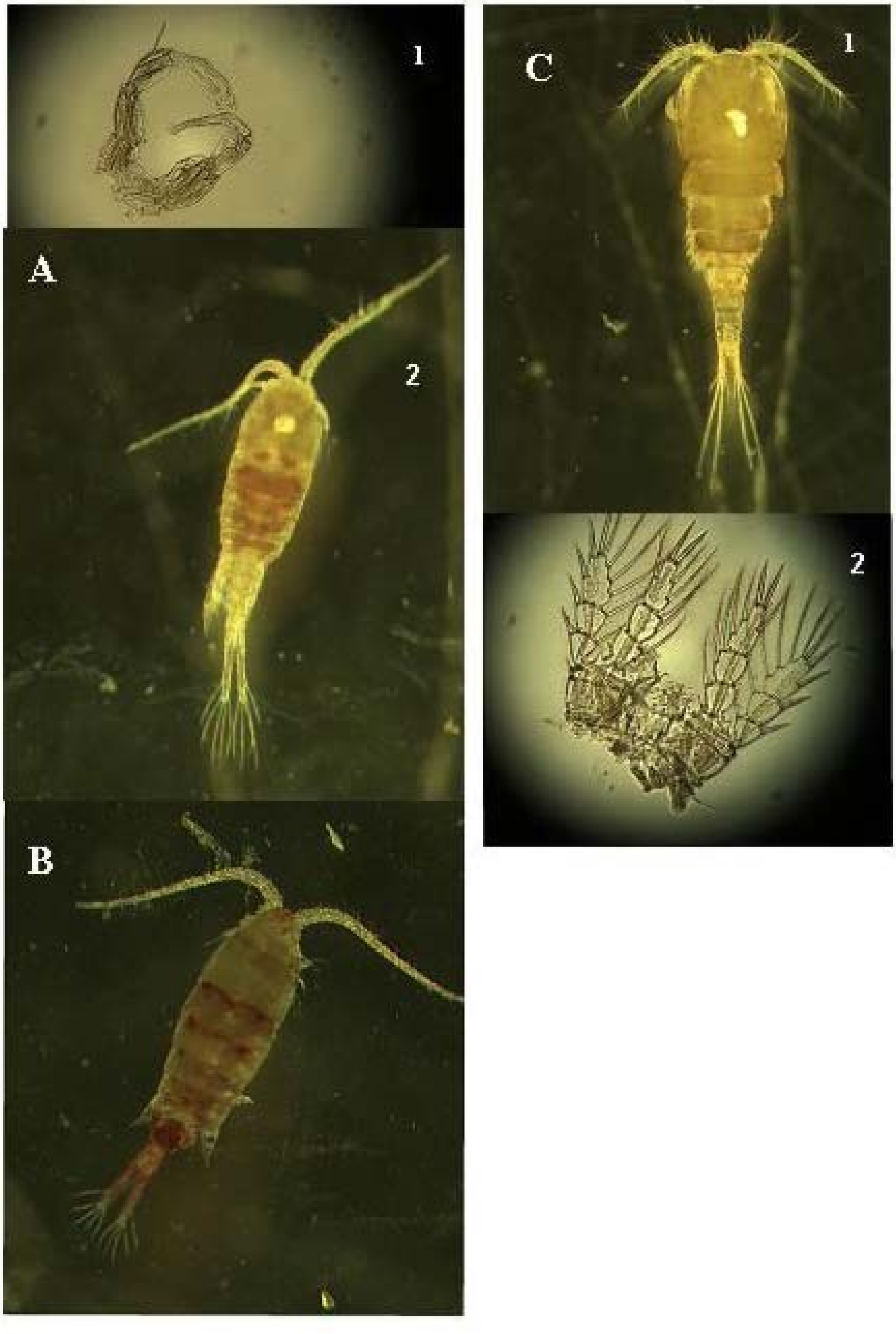

Figure 3-19: Zooplankton from the Olenekskaya channel and flood-plain lakes of the first terrace (*Ratatoria* and *Copepoda* species).

Table 3-6: Chlorophyll A concentration and its dynamic in the different water pools on the Samoylov Island in summer 2004.

1. Flood-plain lake						
date	T water	Cl A contain in the concentrat, l	concentrat volum, l	factor of dillution	water volume, l	Cl A concentration, mg/l
29.06.04	2	169.2	0.008	1	1	1.3536
01.07.04	1.5	203.8	0.008	1	1	1.6304
03.07.04	1.3	185.4	0.008	1	0.9	1.648
05.07.04	3.2	53.4	0.008	1	1	0.4272
07.07.04	4.6	358.1	0.008	1	1	2.8648
09.07.04	3	191.6	0.008	1	1	1.5328
12.07.04	5.3	191.8	0.008	1	1	1.5344
14.07.04	4.5	336	0.008	1	1	2.688
16.07.04	7	189.2	0.008	1	1	1.5136
20.07.04	7.9	335	0.008	1	1	2.68
22.07.04	8.2	334.4	0.008	1	1	2.6752
24.07.04	7.2	243.1	0.008	1	1	1.9448
2. Polygonal lake						
29.06.04	5.6	129.6	0.008	1	1	1.0368
01.07.04	7.2	66.83	0.008	1	1	0.53464
05.07.04	9.2	90.51	0.008	1	1	0.72408
07.07.04	13.4	78.59	0.008	1	1	0.62872
09.07.04	11.2	144.1	0.008	1	1	1.1528
14.07.04	10.6	129.9	0.008	1	1	1.0392
16.07.04	11.4	113	0.008	1	1	0.904
20.07.04	7	53.36	0.009	1	1	0.48024
24.07.04	9.6	41.81	0.008	1	1	0.33448
3. Olenekskaya channel						
29.06.04	10.3	117.6	0.009	1	1	1.0584
01.07.04	10.7	109.2	0.009	1	1	0.9828
03.07.04	10.7	91.33	0.009	1	1	0.82197
05.07.04	11.7	119.36	0.009	1	1	1.07424
07.07.04	11.2	113.2	0.009	1	1	1.0188
09.07.04	12.8	125.4	0.009	1	1	1.1286
12.07.04	13.8	198.2	0.009	1	1	1.7838
14.07.04	14	237.5	0.009	1	1	2.1375
16.07.04	15	368.5	0.009	1	1	3.3165
20.07.04	15.5	371.7	0.009	1	1	3.3453
22.07.04	15.3	570.3	0.009	1	1	5.1327
24.07.04	14.3	417.5	0.009	1	1	3.7575
4. Thermokarst lake on the northern of Samoylov						
12.07.04	?	86.22	0.009	1	1	0.77598
13.07.04	8.2	140.8	0.009	1	1	1.2672
15.07.04	9.2	126	0.009	1	1	1.134
22.07.04	9	131.8	0.009	1	1	1.1862

Table 3-7: Nutrients concentration in the water lakes on the Samoylov Island and Olenekskaya channel in June and July 2004.

Date	Water pool	Silicate, $\mu mol\ l^{-1}$	Phosphate, $\mu mol\ l^{-1}$	Nitrate and nitrite, $\mu mol\ l^{-1}$
28.06.04.	polygon	2.06	0.22	0.21
25.07.04.	polygon	2.62	0.05	0.5
28.06.04.	flood-plain lake	14.52	0.08	0.26
25.07.04.	flood-plain lake	20.94	0.07	0.47
28.06.04.	Olenekskaya channel	62.58	0.06	5.4

Historical – faunistic analyses

Freshwater fauna is poorly known in terms of evolutionary paleontology. It is hard to separate ancient freshwater element from the recent one. According to conception about paleo-, meso-, and neolimnic freshwater fauna and considering the number of asymmetric body parts of Copepoda as a criteria of specialization we investigated the pelagic fauna of the Lena-Delta for the presence –absence of any direct ancestors in the sea. Paleolimnic complex included 8 species of Diaptomidae was selected and it seemingly doesn't have direct marine forerunners. Mesolimnic complex with non-evident ancestors includes 12 species of Copepoda from 3 families (Temoridae, Cyclopidae, Canthocamptidae). The youngest neolimnic complex, which is represented by amphibiotic taxa, includes 24 species from four families (Centropagidae – 2 species, Temoridae - 5, Cyclopidae - 15, Tachidiidae - 2). An analysis of relative numbers of amphibiotic taxa in the lakes of the Lena-Delta shows the increasing of taxa level leads to increasing of it's number. This indicates that disconnection of marine and freshwater fauna was directed from family to genera. Relative high abundance of specific freshwater Cyclops of neolimnic complex proves the replenishment of freshwater fauna of this region from mainly amphibiotic taxa. So, the pelagic fauna of the lakes of the Lena-Delta has heterogeneous origin and consist mainly of both recent and modern freshwater elements with amphibiotic brackish-waters organisms of neolimnic assemblage.

3.8 Hydrological Investigations in the Lena River Delta

Irina V. Fedorova, Grigoriy B. Fedorov and Alexander S. Makarov

3.8.1 Introduction

Hydrological investigations in the Lena River delta have been taking place in the frame of Russian-German activity during the last several years. Measurements in the main delta channels (Bikovskaya, Trofimovskaya) and Trofimovsko-Sardahskaya point of bifurcation were performed. Nevertheless research of minor branches is quite important, because they can play the key role in a high river level period.

During summer 2004 researches of the hydrological regime particularities had been proceeded. The main targets were the secondary channels of the Lena River delta: Tumatskaya, Olenekskaya, and Bulkurskaya. In 2004 standard hydrometrical investigation was extend by coring of lakes sediments from the signal lakes on the river catchment. There were following parts of work:

- Water discharge measurements.
- Sediment supplying observation.
- Sampling for hydrochemical composition analysis.
- Collecting of sediment cores from lakes and suspended particulate materials for geochemical analysis.

Hydrological measurements at the beginning of summer period, quantity, and quality analyses extension allowed getting some unexpected results about basin weathering, detachment of intensive riverbed erosion period, and points and particularities of hydrological processes.

3.8.2 Methods

Methods can be separated on two parts: the field methods of hydrological observation and laboratory analyses.

Field observations include theodolite instrumentation, hydrometrical measurements, and sampling. For getting a temporary water level gauge station a four kilometer long field traverse was built from fixed datum to the point of a main field observation on Olenekskaya channel (Figure 3-20 and Table 3-8). Water level was being observed twice a day during all period of measurements in July 2004.

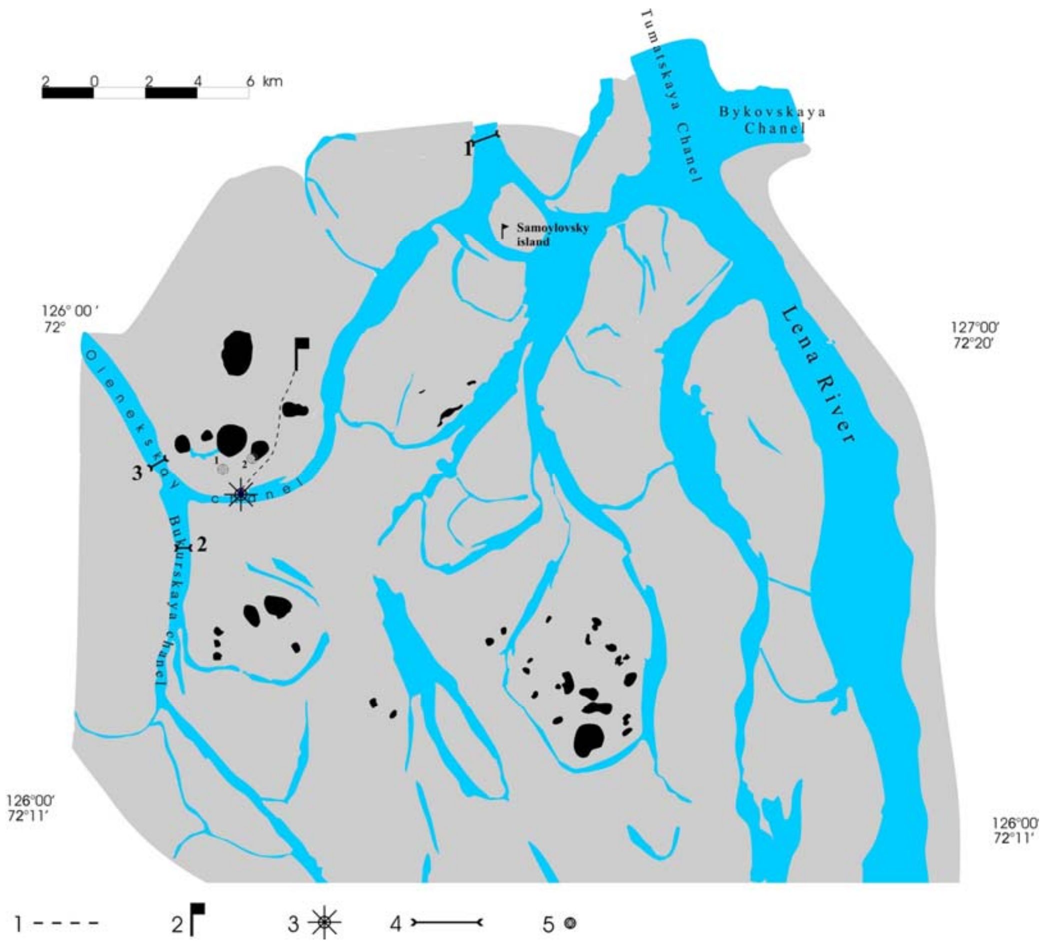

Figure 3-20: Investigated area. 1 - leveling traverse; 2 - fixed datum; 3 - temporary water level gauge station; 4 – gauge lines; 5- locations of the lake sediments coring.

Standard ranges of "Roshydromet" were chosen for hydrometrical investigation on Tumatskaya and Olenekskaya branches. Range on Bulkurskaya channel was the same with line of 2002-year observation. Hydrometrical observations embrace depth, river velocity, and turbidity measurements. Observations were done twice on each branch ranges. Depth determination was done by an echo sounder. Hydrological rotator measured water speed. Turbidity was taken after water sampling by means of a vacuum bathometer, and subsequent filtration through paper filters 10 sm in diameter using a gadget of "Kuprin". River channels depth was fixed each 10 m of a range width. In characteristic point of range profile verticals were settle and were marked by GPS. There were 4-8 verticals on the ranges depending on branch width. Velocity and turbidity determination were observed on some horizons (surface; 20, 60, 80 % below surface; bottom) of each vertical. In general about 70 samples were got and were treated for turbidity carrying out.

Unfortunately in the absence of suitable ship in field period 2004 for the main Lena River channel only depth measurements were done.

Some analyses of samples were done in a field, for example, turbidity. But the most part of water, sand, filters (suspended particulate materials), and sediment cores analyses were carried out after the expedition in the Alfred Wegener Institute (Potsdam) laboratory. There were hydrochemistry and geochemistry analyses of water, sediment, and alluvium samples based on inductively coupled plasma optical emission spectrometry, graphite furnace atomic absorption spectroscopy, that are all elemental analytical techniques used for the measurement of trace and minor components in liquid samples or solid samples after acid digestion. Determination of total organic carbon and total carbon were done by TOC analyzers using. Working on Laser particle sizer allowed having granulometric composition of sediment samples.

For water and alluvium samples analyses were used following equipment: pH-meter, conduct meter, laser particle sizer, ICP-OES, GF-AAS, ion chromatograph, TOC analyser. Radiocarbon dating of lake sediment cores is ongoing now.

3.8.3 Field Work

The first part of the hydrological investigation consists of riverbed hydrometrical, velocity on different depth, water level fluctuation, and water discharge measurements. The whole complex of work was made twice: at the beginning of the expedition period and at the end. Hydrological situation in the end of June can be recognized as a decrease of a spring tide. Consequently measurements were quite complicated due to a high stream velocity and a partial ice drifting. Repeated hydrometrical observation was made in the secondary decade of July. During July water level was observed on the temporary water level gauge station at Olenekskaya branch, which coordinates are shown in Table 3-8. Points of all ranges are also presented in Table 3-8. Somewhere coordinates of banks are inaccurate because of impossibility of exactly observation getting on account of instrument errors or very small channel depth.

For getting water discharges depth and velocities were measured. Maximal depth of Tumatskaya channel was 16.9 m on 30 June and 14.1 m on 21 July, of Olenekskaya – 10.6 m on 6 and 9.7 m on 14 July; 8 m on 4 and 5.9 m on 17 July for Bulkurskaya branch. Larger depth in Tumatskaya and Olenekskaya channels was nearby a right bank and approximately in the middle of Bulkurskaya branch. Velocity of branches increased up to 1.5 m sec^{-1} (Table 3-9). Surface velocity was more higher than bottom one, but sometimes speed on 20 % of depth below surface was a maximal on a vertical. Velocity distribution on horizontal line through ranges there was not stable in time: almost maximal speed was in a fairway, but as usual it as nearby a right or a left bank. It allows recognizing direction of bank (slopes) erosion. Therefore, in the first part of hydrological measurements in Tumatskaya branch maximal velocity was noticed close to the right bank, in Bulkurskaya - to the left bank on 04 and in the middle on 17 July, Olenekskaya – close to the right bank. In the second part of hydrometrical observations in Tumatskaya branch the maximal velocity was observed also close to the right bank and in the middle of Bulkurskaya (17.07.04) and Olenekskaya (19.07.04) channel.

Table 3-8: Coordinates of water measurements.

Name of a branch	bank	Longitude (E)	Latitude (N)	Date
Tumatskaya branch	Right bank	126° 27.341′	72° 25.112′	30.06.04
	Left bank	126° 25.396′	72° 25.016′	30.06.04
Bulkurskaya branch	Right bank	126° 08.127′	72° 14.742′	04.07.04
	Left bank	126° 06.026′	72° 14.802′	04.07.04
Olenekskaya branch	Right bank	126° 05.719′	72° 17.761′	06.07.04
	Left bank	126° 04.268′	72° 17.383′	06.07.04
Temporary water level gauge station	Right bank of Olenekskaya branch	126° 11.582′	72° 16.880′	04.07.04

Results of water discharge and water level fluctuation observations for Tumatskaya, Bulkurskaya, and Olenekskaya branches are presented in Figure 3-21.

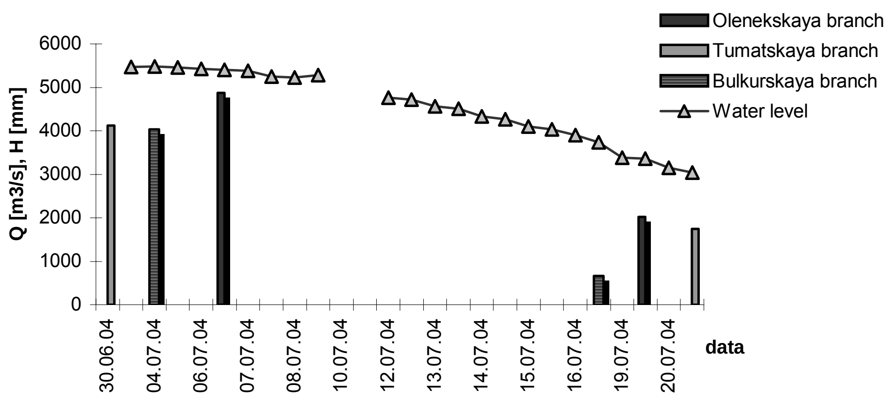

Figure 3-21: Water level (H, mm) and discharge (Q, m^3 s^{-1}) of Bulkurskaya, Olenekskaya, and Tumatskaya branches in summer 2004.

The second part of the hydrological investigation was sediment and suspended particularity materials (SPM) supplying. Observations of suspended supplying were made also twice on the same ranges. In the Table 3-9 there are suspended supplying, and highest turbidity and velocity for three channels. Sampling on filters for following determination turbidity and suspended supplying some vertical lines and horizons were used on each ranges. It allows seeing turbidity distribution in horizontal and vertical lines in a river. In a vertical distribution turbidity near bottom as usual is bigger than on surface. In the Table 3-9 only one measure (Olenekskaya, 19.07.04) was observed on 20 % below surface. Others were noticed near a bottom. Regularity of a turbidity distribution through river width was not marked. Maximal suspended matter quantity in Tumatskaya branch observed not far from a left shallow bank and in the middle of Olenekskaya and Bulkurskaya channel.

Table 3-9: Water turbidity, velocity, and suspended supplying.

Name of a branch	Data	Sediment supplying, kg sec^{-1}	The maximal turbidity, g l^{-1}	The maximal water velocity, m sec^{-1}
Tumatskaya branch	30.06.04	385,86	0,18	1,2
	21.07.04	63,62	0,07	0,69
Bulkurskaya branch	04.07.04	487,77	0,20	1,07
	17.07.04	5,93	0,01	0,32
Olenekskaya branch	06.07.04	435,48	0,11	1,45
	19.07.04	48,79	0,03	0,85

Sediment supplying of the minor channel Bulkurskaya was the biggest in high – river-level time, and the smallest in a lower-level period. In opposite that supplying of Tumatskaya branch could be bigger from three investigated channels in a summer limited period.

The high concentrations of suspended matter and maximal speed distribution as usual were observed on different points of ranges. That is why measurements have to be planed more carefully with preliminary analysis of riverbed erosion processes particularities.

The third part of hydrological investigations was sampling for research of hydrochemical composition. Water for hydrochemical analysis was sampling from Tumatskaya, Bulkurskaya, Olenekskaya channels and from lake #1 that is situated in alass, and lake #2 that is situated on the first river terrace. GPS-positions of the points of sampling are shown in Table 3-10. Samples were taken on surface and bottom of channels and only on surface for lakes.

Table 3-10: Position of water sampling.

Place of samples taken	Depth, m	Longitude (E)	Latitude (N)	Date
Tumatskaya channel	Surface	126° 27.094′	72° 25.106′	30.06.04
	Bottom(11,68 m)	126° 26.969′	72° 25.028′	01.07.04
Bulkurskaya channel	Surface	126° 06.748′	72° 14.862′	04.07.04
	Bottom (4,1 m)	126° 06.318′	72° 14.843′	04.07.04
Olenekskaya channel	Surface	126° 05.022′	72° 17.567′	06.07.04
	Bottom (8,7 m)	126° 05.022′	72° 17.567′	06.07.04
lake #1 (alass, 3rd terrace)	Surface	126° 12.080′	72° 17.720′	15.07.04
lake #2 (1st terrace)	Surface	126° 10.682′	72° 17.215′	13.07.04

All samples were analysed in the AWI laboratory during October-December 2004. In Table 3-11 there are main elements content in the samples.

Table 3-11: Hydrochemical composition of water samples.

Place of sampling	pH	Conductivity (µs/cm)	Ca %	Mg %	Na+K %	Cl^- %	SO_4^{2-} %	NO_3^- %	HCO_3^- %
Tumatskaya, surface	6,55	97,0	35,61	14,76	9,82	6,80	6,23	0,16	42,32
Tumatskaya, bottom	6,32	95,6	35,28	15,05	8,98	6,22	5,80	0,42	42,89
Bulkutskaya, surface	6,27	84,7	30,70	12,76	7,87	5,44	5,36	0,20	37,67
Bulkurskaya, bottom	6,53	84,3	30,69	12,90	7,79	5,31	5,31	0,00	37,78
Olenekskaya, surface	6,40	83,2	30,03	12,50	7,96	5,52	5,46	0,00	36,76
Olenekskaya, bottom	6,57	86,5	30,72	13,21	7,93	5,49	5,47	0,00	37,56
Lake # 1, surface	6,76	105,1	39,72	22,02	4,25	2,97	0,72	0,00	60,93
Lake # 2, surface	6,47	79,0	22,53	15,94	8,24	6,75	2,22	0,00	36,20

Bulkurskaya and Olenekskaya branches water conductivity is similar (the first one inflow to the second). Salinity of Tumatskaya channel is a little bit higher. The main cation in all samples is calcium Ca^{2+}, the prevailing anion is hydrocarbonate HCO_3^- Trace elements have been noticed only in water from Tumatskaya channel. Hydrochemical composition of lakes, which are situated on the first river flood terrace and in alass, is more interesting and various. Conductivity and pH in water from lakes #1 are above than in the lake #2 and close to investigated polygonal lake composition in the Lena River delta. Element compound of the lake of the 1st terrace simulates water from river channels.

The fourth part of the hydrological researches was sampling of sediment cores from lakes and suspended particulate materials for geochemical, TOC/TC, and grain-size analyses. List of samples and carried out analyses are shown in Table 3-12. Detailed analysis can assist to understand when and how environment in the Lena River delta had been changed. Features of parameters on the deferent core's layers show conditions when that matter was accumulated. Periods of isolation from river and a possibility of river runoff (water input) to the lakes could be seen according at the TOC/TC, grain-size, and geochemical analysis.

Due to on-going analyses, conditions in the lake #1 were more homogeneous than in the terrace's lake to all appearances. In environment of the lake #2 some period of different type of formation can be noticed on the strength of characteristics various in the core depth.

Organic carbon content in samples is not so high and to average 3 %. Only for filers of Tumatskaya channel and sediment core from the lake # 1, 2 (in the core surface) TOC can rise more than 4%. Percentage of TOC/TC in sand samples is very low (about 0.15%) except Tumatskaya branch.

Grain-size shows that the main part of sediments is silt and, sometimes, sand. Distribution of the sediment core from the lake #1 can be characterised by the average median 25,4 *μm* – medium silt. Grain-size of the lake #2 has median range from 46,5 *μm* in the top of core up to 108,6 *μm* in the core's depth. It is means that there are fine sand on the bottom of taken core, very fine sand in the middle, and coarse silt in the surface one. Sediments from lake #2 varieties from river sand to clay that allows recognising a basin weathering. Moda of SPM ranges in (20; 55) *μm*.

Based on a preliminary geochemical analysis two groups of main elements can be marked: the first is Al_2O_3, Fe_2O_3, MnO, P_2O_5, TiO_2, which connects with a trace element vanadium *V,* and the second group is K_2O, Na_2O, *Ba,* which concerned with strontium *Sr.* An abundance of *Sr* and *V*, and their ration can be used for recognised a weathering of a chemical composition in the Lena delta region.

Table 3-12: List of samples for geochemical, TOC/TC, and grain-size analyses.

	Place of sampling, data, depth	Position		Ongoing analyses			
		Longitude (E)	Latitude (N)	Grain-size	Geo-chemistry	TOC/ TC	Radiocarbon dating
sand	Olenekskaya, 20.07.04, bottom	126° 26.270′	72° 25.038′	+		+	
sand	Tumatskaya, 01.07.04, bottom	126° 26.033′	72° 24.988′	+		+	
sand	Tumatskaya, 01.07.04, bottom	126° 27.341′	72° 25.112′	+		+	
sand	Bulkurskaya, 4.07.04, bottom	126° 07.408′	72° 14.727′	+		+	
sand	Bulkurskaya, 4.07.04, bottom	126° 06.318′	72° 14.843′	+		+	
sand	Bulkurskaya, 20.07.04, bottom	126° 27.341′	72° 25.112′	+		+	
cores	lake #1 (alass, 3rd terrace), 15.07.04, 8.1 m, (core length 47.5 sm)	126° 12.080′	72° 17.720′	+	+	+	+
cores	lake #2 (1st terrace), 13.07.04, 4.5 m, (core length 36 sm)	126° 10.682′	72° 17.215′	+	+	+	+
filters	Tumatskaya, 30.06.04, 8,7 m	126° 27.352′	72° 25.078′	+	+	+	
filters	Tumatskaya, 30.06.04, 11,2 m	126° 27.352′	72° 25.078′	+	+	+	
filters	Tumatskaya, 30.06.04, 3,66 m	126° 27.341′	72° 25.112′	+	+	+	

	Tumatskaya, 30.06.04, 14,64 m	126° 27.094′	72° 25.106′	+	+	+	
	Tumatskaya, 30.06.04, 7,86 m	126° 27.030′	72° 25.031′	+	+	+	
	Tumatskaya, 30.06.04, 10,48 m	126° 27.030′	72° 25.031′	+	+	+	
	Tumatskaya, 30.06.04, 5,34 m	126° 26.792′	72° 25.002′	+	+	+	
	Tumatskaya, 30.06.04, 7,12 m	126° 26.792′	72° 25.002′	+	+	+	
	Bulkurskaya, 4.07.04, 5,28 m	126° 07.408′	72° 14.727′	+	+	+	
	Bulkurskaya, 4.07.04, 1,44 m	126° 07.161′	72° 14.757′	+	+	+	
	Bulkurskaya, 4.07.04, 5,76 m	126° 07.161′	72° 14.757′	+	+	+	
	Bulkurskaya, 4.07.04, 1,18 m	126° 06.748′	72° 14.862′	+	+	+	
	Bulkurskaya, 4.07.04, 4,72 m	126° 06.748′	72° 14.862′	+	+	+	
	Olenekskaya, 06.07.04, 0,45 m	126° 04.268′	72° 17.383′	+	+	+	
	Olenekskaya, 06.07.04, 2,16 m	126° 04.845′	72° 17.506′	+	+	+	

3.8.4 Preliminary Results

There are some scientific preliminary conclusions can be arrived after the fieldwork in 2004, therefore. They are following:

Water discharges of the three investigated branches in the first step of measurements were twice as many as in second time. That is why hydrometrical observations should be repeated in different hydrological stages.

Water discharge and possibility of sediment and SPM transportation in Bulkurskaya (minor) branch could be equal run-off volume and characteristics of the Lena River major channels in a top-level time. It can be a reason of vigorous riverbed erosion in the branch and in the point of Bulkurskaya and Olenekskaya junction.

Observation of slopes and banks erosion should be based on detailed measurements in different points of the delta area, on ranges of major and minor channels, on horizontal and vertical lines, and in a several time.

River and lake hydrochemical composition can represent processes of water formation and transportation in the delta.

Analyses of sediment cores from lakes, situated on alasses and on the different river terraces, can be helpful for considering of velocity and processes of basin (water catchments) erosion.

3.8.5 Conclusion

During the expedition to the Lena River delta in summer 2004 some important and unexpected hydrological results have been received. On the one hand, it was possible because of measurements beginning in spring of hydrological cycle and opportunity to observe in flood time. On other hand, choosing the signal points for studies allowed obtaining several interesting scientific infers. Confirmation ours conclusions need prolongation of more comprehensive hydrological investigation in this direction for different places of the Lena River delta.

3.9 Geomorphological Studies in the Lena River Delta

Alexander S. Makarov, Grigoriy B. Fedorov and Irina V. Fedorova

3.9.1 Introduction

Geomorphologic investigation in the upper part of Lena River Delta was connection with hydrological program (see «hydrological studies» in this report) and directed to studying of modern and former sediments transport dynamics and their accumulation. The area of investigation was bordered by Bulkurskaya and Olenekskay channels and main channel of Lena River. The main camp (#1) of geomorphologic and hydrological group situated at the Samoylovsky Island (Figure 3-22), other one (#2) situated near the confluence of the Olenekskay and Bulkurskay channels. The main part of field work was concentrated near the camp #2.

The general aim of the investigation was the studying of geomorphic structure of this area and river-bed forms in this part of Lena River Delta. The main result of the work is the geomorphic map, which was originally made in scale: 1:100000 (Figure 3-22).

3.9.2 Methods

The main method of the field studies was the method of geomorphic survey. In the Lena River Delta condition, with the many different channels, we used a boat “Kazanka 5M” with Johnson 25 engine. By the decoding of satellites images and air-photos the key sites were marked. For that was used method of etalon decoding, which allowed us to made geomorphic map with all variety of land-forms occurs in this area. The field work was mainly concentrated on geomorphic observations, logging and sampling of outcrops in the key sites.

3.9.3 Results

As the main result of investigations the geomorphic map was performed (Figure 3-22). Four river terraces levels were recognized in this area: low flood-plain, high flood-plain, first river terrace, second river terraces.

Low flood-plain occupy the maximum square. This terrace has relative height 5 m. The height positions of all sites were measured above minimum observed water level during field work period (see «hydrological studies» in this report). It formed by fine-grained light-fawn coloured sand with high detritus content. The surface of this terrace isn’t covered by vegetation and polygons. In this season the low flood-plane was mostly covered by river ice blocks. The ice blocks were observed on 5m relative height with thickness reached 2-2.5 m. Some buried firns were observed in the body of low flood-plain. One of them – closely to the camp #2 (Figure 3-22), in the mouth of little tributary of Olenekskaya channel.

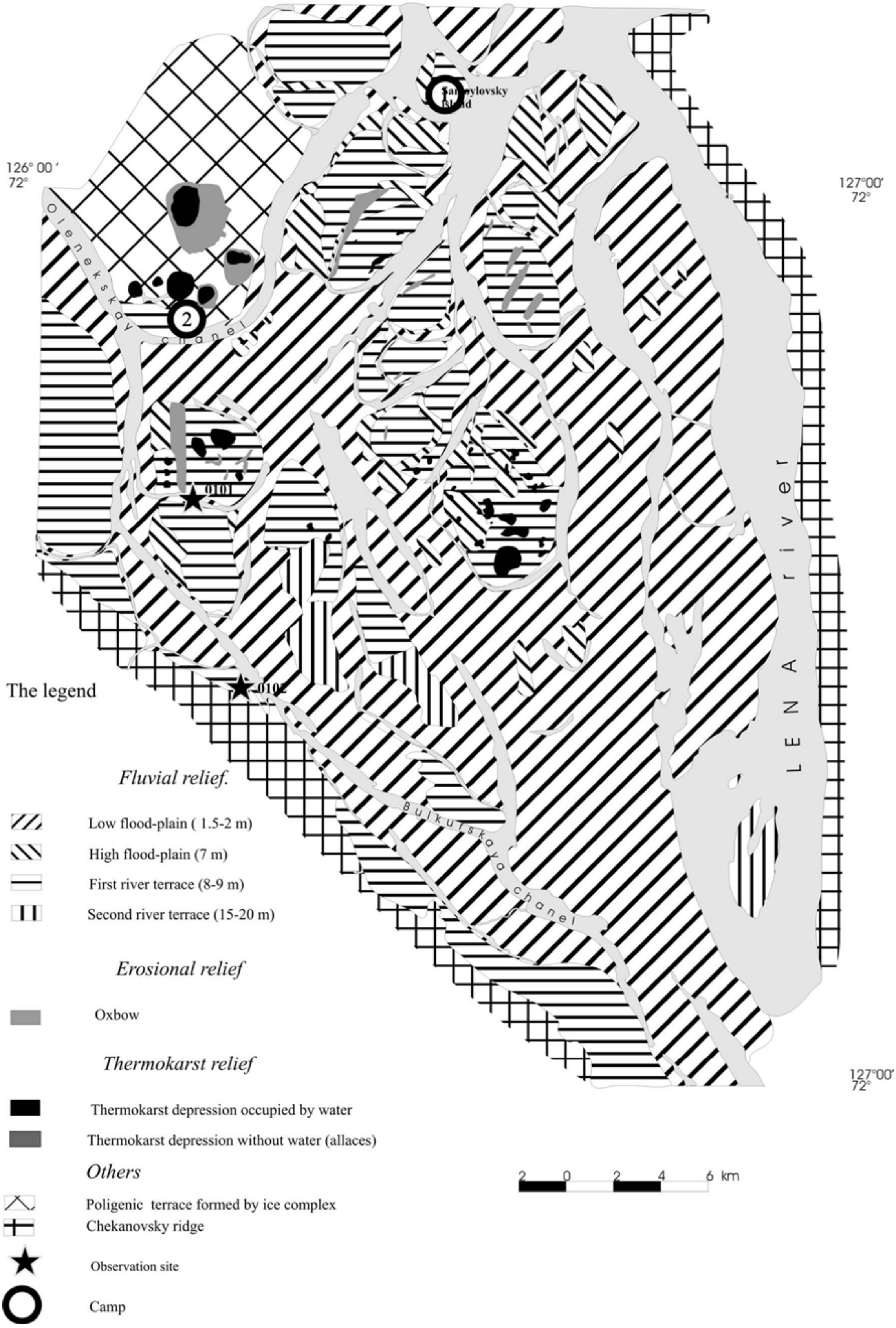

Figure 3-22: Geomorphic map of the upper part of Lena River Delta.

High flood-plain have relative height 5-7 m. It formed by fine and medium-grain light brawn sand. Surface has non-continues vegetation cover. In this season during the spring flood time water level was not so high, that's why high-flood-plain was not covered by ice. There have no evidences of ice activity on the high flood-plain surface. Only in the few locations we observed ice blocks with 1.5 m thickness.

First river terrace with the relative height 5-7 m occurs lesser square than low flood-plain. Sediments of this terrace have a various lithological content in different part of working area. In observation site 0102 (see Figure 3-22) it is mostly fine sand. The first terrace surface has continues vegetation cover. The polygon net is developed on this surface. Diameter of polygons reached 20 m. The polygons walls have a relative height 0.6 m and width is about 1 m. There are a lot of small lakes in the central parts of polygons. The depth of polygon lakes reached 30-40 sm.

The most representative for this area outcrop of the first terrace was studied in observation site #0102 (Figure 3-23). In the 7 m height terrace cusp fine-grained grainy-brown polymictic sand and brown silty sand with horizontal and wave-like lamination, are exposed. The thicknesses of these layers are the 5-7 sm. The deposits characterized by a high content of detritus. It reached 50% of the total volume. On the 1.7-5.1m depth observed the slope deformation. In the lower part of outcrop at 2 m above the water level (6.4 m depth) is thermoerosional niche. It has unknown depth, because of full filling of this niche by the modern alluvium. It is fine-grained pale yellow and light yellow sand. In this site first terrace has 8.5 m relative height. Surface assimilated by vegetation. Diameter of polygons is about 10-15m, wall height – 50-60sm, width – 1 m. 17 samples on pollen analyses including 8 on radiocarbon dating, were collected.

Second river terrace has sporadic range. It has relative height about 14-20m. This terrace formed by fine-grained light coloured sand. The surface of second river terrace has continues vegetation cover. The terrace surface is typical polygonal tundra with lot of thermokarstic lakes which have different diameters and depths.

The important part of geomorphic structure in investigated area is the polygenetic terrace surface formed by ice complex deposits. It has about 25 m reletive height and ice content in the terrace deposits reached 80 %. The surface was rich of alass and modern thermokarstic lakes depressions.

Erosional land-forms include the oxbow-lakes, which observed on the every island in this area. The largest one was observed closely to observation site #0101 (see Figure 3-22). Its width is about 700 m, depth reached 3-4 m. Mostly erosional land-forms constitutes valleys of different morphological types. It situated on the periphery of working area. These valleys develop in the body of polygenetic terrace 25-30 m height or in foothills of Chekanovsky ridge. The depth of erosional valleys is 5-6 m, width – first teen's m. It can be both linear and meanderer.

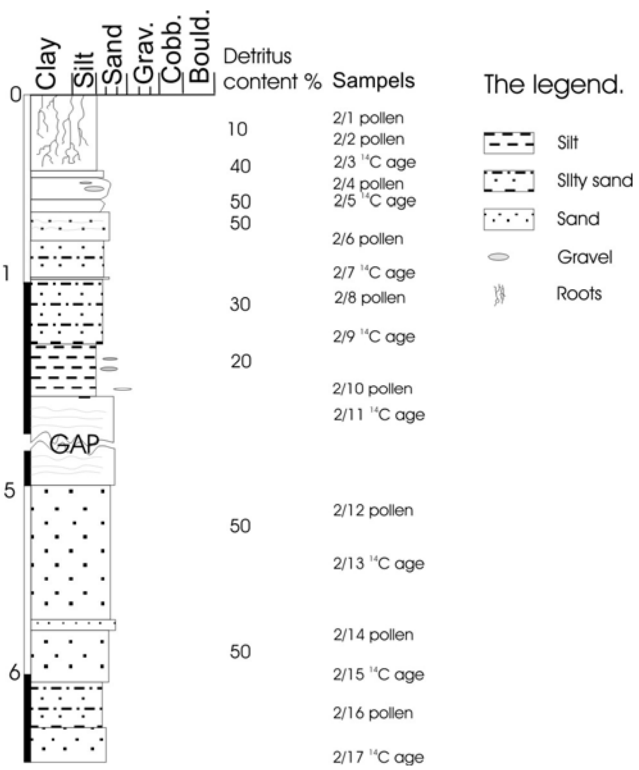

Figure 3-23: Sediment log of the outcropping first river terrace alongside the left shore line of Bulkurskaya Channel (observation site 0102; see Figure 3-22).

Thermokarstic forms are widespread on the territory. Small thermokarstic lakes situates on the surfaces of the river terraces. The largest ones observed on the polygenetic terrace 25-30 m height. Width of these form reached 1-2 km, depth – 10 m. The large thermokarst lakes can has connection with each other and with Olenekskaya channel.

During the investigation the sediments of two thermokastic lakes were sampled by short gravity coring equipment (GOIN-1). Three cores were recovered from lake #1 and one from #2 (Figure 3-22). For more information see “hydrologycal studies” in this report.

3.10 Recent Cryogenesis

Hanno Meyer and Victor Kunitsky

The main aim of studying recent cryogenesis processes is to establish a stable isotope thermometer for ice wedges. The recent ice veins are attributed to the discrete year of their formation by means of tracer experiments. A tracer (coloured lycopodium spores) is applied to a polygon with recent cryogenesis, which allows identifying all types of ground ice, which were formed in the considered year.

Studies on recent ice wedge growth were carried out for a polygon at the 1st Lena River terrace of Samoylov Island. For a detailed description of the site and the experimental set-up of the first and the second year, see Meyer (2003) and Meyer & Schneider (2004). 10 different recent frost cracking experiments were carried out. The general set-up of every single experiment consists of two about 1 m long steel poles (e. g. 1A and 1B) inserted to the permafrost on both sides of a frost crack. Between two steel poles, a breaking cable was installed. All experiments in 2004 were equipped with voltage data loggers (type ESIS Minidan Volt) connected to the cables, which should break at the moment of frost cracking. It is expected that the experimental set-up shows a.), if frost cracking took place and b.) the precise moment of frost cracking. The loggers measure every 20 minutes from the moment of installation until the moment of frost cracking.

Between 2003 and 2004, nine out of ten experiments were successful and broken cables were observed. Only at experiment 6A-6B, the cable was still in place, however, traces of animal bites (polar fox?) were observed at this experiment. At experiments 3A-3B, 5A-5B, 8A-8B and 9A-9B, the cables did not break completely and an electrical contact was still possible. All other cables were broken. Experiment 1A-1B did not break until 3 February, 2004 then stopped logging. The cables of experiment 3A-3B broke on 25 February, 2004 and stopped logging on 28 February, 2004. Experiment 7A-7B cracked on 18 October, 2003, experiment 8A-8B on 8 January, 2004, experiment 9A-9B on 12 December, 2003 and experiment 10A-10B on 9 November 2003. Loggers of experiments 2A-2B, 4A-4B and 5A-5B failed.

The distance to two fix points (poles 11 and 5b) was measured and compared to the data of 2003 (Table 3-13).

Table 3-13: Characteristics of 22 steel poles: length, height above surface, distance to fix points (poles 11 and 5b) and depth in permafrost as well as the active layer depth.

	2003 (30.08.)	2004 (28.08)	Difference 2003-2004	2002 (09.08.)	2003 (30.08.)	2004 (28.08.)	Difference 2003-2004
Steel pole	distance to M11A	distance to M11A	distance to M11A	distance to 5b	distance to 5b	distance to 5b	distance to 5b
Nr.	(cm)	(cm)		(cm)	(cm)	(cm)	(cm)
1a	934,6	929,2	5,4	-	-	-	-
1b	915,4	918,3	-2,9	1171,8	1172	1175,9	-3,9
2a	828,9	828,4	0,5	-	-	-	-
2b	783	787,3	-4,3	944	944	948,1	-4,1
3a	854,2	859,5	-5,3	-	-	-	-
3b	824,6	828,4	-3,8	763,2	763,8	761	2,8
4a	769,2	770,6	-1,4	-	-	-	-
4b	732,2	734,8	-2,6	552,3	552,7	553,6	-0,9
5a (new)	596,8	631,7	-	-	-	-	-
5b	579,1	584,7	-5,6	0	0	0	0
6a	594,8	594,2	0,6	-	-	-	-
6b	562,7	556,8	5,9	465	466	469,2	-3,2
7a	983,3	986,2	-2,9	-	-	-	-
7b	969,8	968,7	1,1	991,1	992	986,1	5,9
8a	762,7	758,5	4,2	-	-	-	-
8b	718,8	718,5	0,3	977,2	979	987,0	-8
9a	605,6	604	1,6	-	-	-	-
9b	565	564,2	0,8	1030,4	1031,3	1038,5	-7,2
10a	660,6	665,2	-4,6	-	-	-	-
10b	639,6	640,4	-0,8	1217,3	1218	1223,3	-5,3
11	0	0	0	660,2	660	-	-
12	---	-		472,8	474	-	-
13a		770,3	-	-	-	729,8	0,2
13b		868,3	-	-	-	821	-1,2

For the new installation of the experiments, the tension of the wires (Cu two-wire braid, HO3VH-H, 2x0.75, Cu wire 0.5 mm) was increased by counting the turnarounds of the nut (type M5) on the thread rods (Table 3-14, compare Meyer, 2003).

Table 3-14: Ten stretching experiments with applied cables and voltmeters, the lengths of the breaking cables between the poles A and B before spanning the cable (1) and after the cables were stretched (2). The tension of the wires was increased by counting the revs (or turnarounds) of a nut (type M5) on the thread rod. For every cable type, maximum revs were calculated according to its length by means of the breaking experiments. Based on this a relative tension is given in % - in general around 70%).

Marker	Voltmeter	Cable type	Cable length (28.8.04)		Diffe-rence	Turn-arounds	Turn-arounds	Tension
			1	2		applied	max.	%
1A-1B	1	Cu two-wire braid (HO3VH-H, 2x0.75)	195	198	-3	20	28	71
2A-2B	2	Cu wire (0.5)	172	178	-6	13	18	73
3A-3B	3	Cu two-wire braid (HO3VH-H, 2x0.75)	139	146	-7	14	21	67
4A-4B	4	Cu wire (0.5)	249	254	-5	18	25	71
5A-5B	5	Cu two-wire braid (HO3VH-H, 2x0.75)	381	392	-11	38	56	68
6A-6B	6	Cu wire (0.5)	221	224	-3	15	22	67
7A-7B	7	Cu two-wire braid (HO3VH-H, 2x0.75)	255	256	-1	26	37	71
8A-8B	8	Cu wire (0.5)	250	253	-3	22	25	87
9A-9B	9	Cu two-wire braid (70236, 2x0.75)	311	314	-3	32	45	71
10A-10B	10	Cu two-wire braid (70236, 2x0.75)	188	151	37	19	22	88

Additionally, the distances between the two poles of each experiment (e.g. 1A and 1B) was determined again in 2004 and compared to the results of 2003 (see Table 3-15). These distances were measured at three respective heights of the poles A and B of an experiment, i.e. at the top, at the bottom and at a tape mark in the middle of the poles. It should be noted that experiment 5A-5B was newly installed since one of the poles was too loose. At almost all experiments between the poles decreased most likely due to the movement of the poles caused by the tension of the stretched breaking cables.

Table 3-15: Respective distances (in mm) between the poles A and B measured from the a.) top to the top, b.) tape mark to the tape mark and c.) bottom to the bottom, after the cables were stretched.

Marker	Distance Top-Top		Diff	Distance Tape-Tape		Diff	Distance Bottom-Bottom		Diff
	2003	2004		2003	2004		2003	2004	
1A-1B	306	305	1	315	308	7	345	346	-1
2A-2B	383	371	12	392	381	11	402	389	13
3A-3B	262	254	8	266	259	7	288	277	11
4A-4B	379	367	12	388	379	9	386	378	8
5A-5B (new)	169	511	-	174	502	-	180	490	-
6A-6B	356	348	8	361	349	12	354	346	8
7A-7B	332	308	24	334	314	20	338	322	16
8A-8B	351	362	-11	396	371	25	411	392	19
9A-9B	359	344	15	374	364	10	397	395	2
10A-10B	230	225	5	232	235	-3	264	268	-4

The temperature loggers Temp-1 to Temp-4 were removed from the polygon for calibration purposes and will be installed again in 2005.

Generally, the polygons were relatively wet with water standing in the polygon troughs, e. g. on both sides of experiment 8A-8B, at the triple junction of frost cracks near experiment 3A-3B and near experiment 9A-9B.

For the attribution of ice veins to the discrete year of their formation, tracer experiments were carried out. In late summer, 1 kg of crystal violet coloured *lycopodium* spores was applied to the polygon walls, especially to the apexes above the frost crack to avoid drifting of the spores by wind. In spring, when the snow cover melts, the spores are expected to be washed into the crack. Since the melt water freezes immediately, the spores are conserved in the newly formed ice vein, which can clearly be attributed to the year of its formation and then sampled for stable isotope measurements.

4 Studies on Recent Cryogenesis in the Yakutzk Area

Hanno Meyer, Victor Kunitsky, Alexander Dereviagin, Igor Syromyatnikov, Radomir Argunov

The studies on recent cryogenesis in the Yakutsk area are the continuation of previous investigations on Samoylov Island, Lena Delta area (see Chapter 3.10). The Samoylov site is located in continuous permafrost relatively close to the Laptev Sea, whereas the two selected working areas near Yakutsk, site “Neleger” and site “Vilyuysky Trakt”, represent a continental equivalent of permafrost. Both sites are characterised by extreme climatic conditions with winter temperatures reaching -55°C and summer temperatures of 25°C and more. However, there are some major differences: permafrost temperatures may reach –8° to -10°C in the Laptev Sea region, whereas in the Yakutsk area, permafrost temperatures are much higher (-2° to -4°C). The active layer thickness is between 0.3 m in the Laptev Sea region, whereas near Yakutsk it may reach 1 m and more. These facts are certainly linked with a different behaviour of the upper metres of permafrost related to the process of frost cracking and to the formation of recent ice wedges or ice veins.

The main aim of the investigation is the establishment of a stable oxygen and hydrogen thermometer. For this purpose, coloured lycopodium spores are applied to an area, where recent frost cracking does occur. These spores (each year a different colour, crystal violet in 2004) are expected to be washed into an open frost crack during snowmelt in spring. They are therefore applied to the trough in the polygon wall and are supposed to be indicative for frost cracking (and recent ice wedge formation). Following, the year of formation of every single ice vein may be identified by means of the colour of the spores found in it. Other recent cryogenic processes, such as the formation of segregated ice may also be traced. The stable isotope analysis of ice veins attributable to the year of its formation and the correlation of the resulting isotopic composition to the climatic conditions during its formation are the starting point for a temporal oxygen and hydrogen isotope thermometer based on ice wedges. Obviously, it is aimed to use the stable isotope thermometer for the estimate of palaeo-temperatures of Holocene and Pleistocene ice wedges.

Additionally, frost cracking experiments with breaking cables were carried out at both sites near Yakutsk as well as on Samoylov Island to derive information on the presence or absence of frost cracking in a discrete year, and, secondly, to the timing of frost cracking in winter. This may certainly be used to gain more information on the specific characteristics of frost cracking in these two different permafrost regions. The studies on recent cryogenesis are accompanied by extensive studies and sampling of the snow cover and its isotopic composition throughout the winter with special emphasis on isotope fractionation due to sublimation, formation of hoar frost and melting.

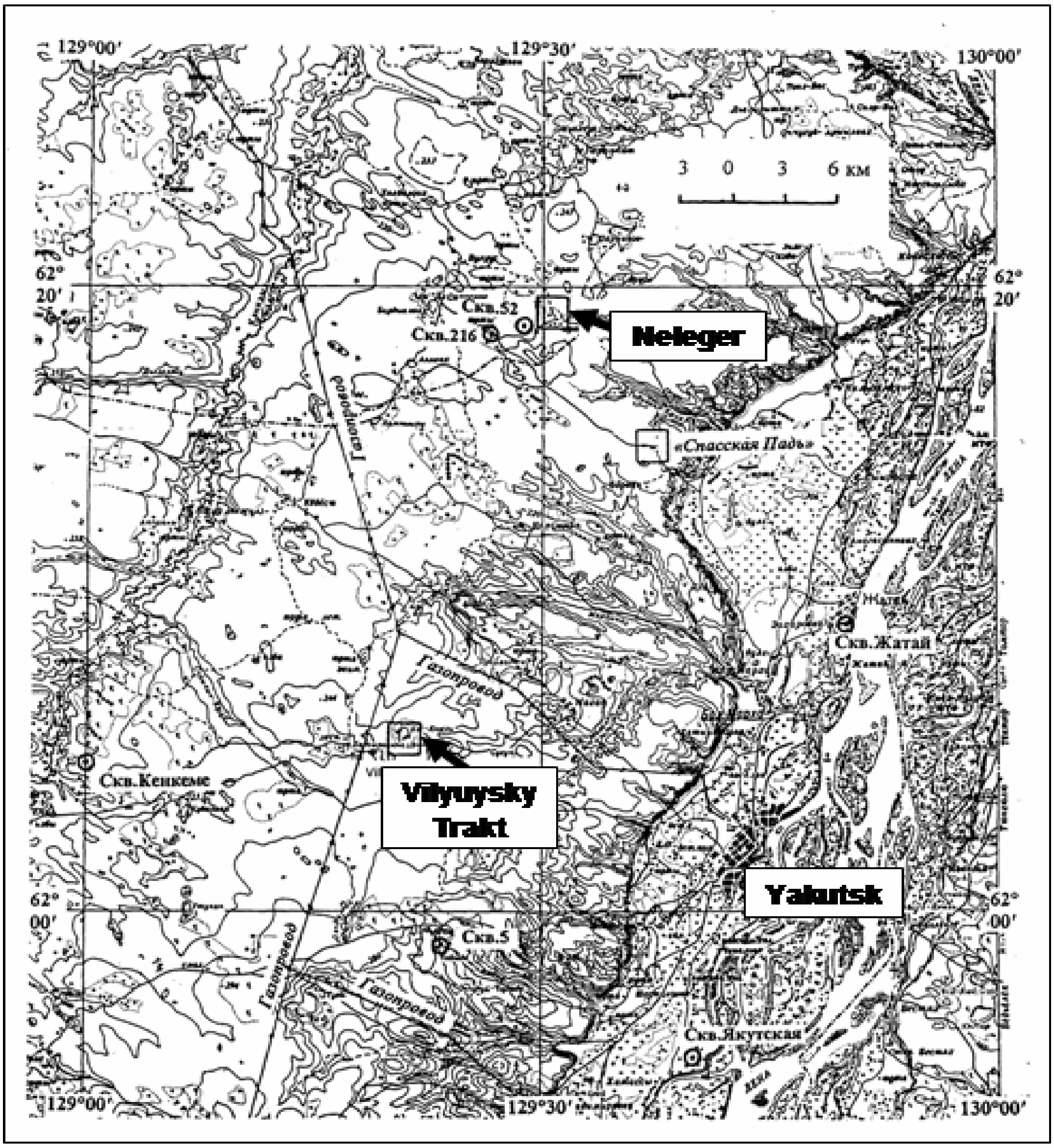

Figure 4-1: Location of the two working areas near Yakutsk.

Two sites were selected near Yakutsk according to the available logistical and scientific background information: 1) “Neleger” and 2) “Vilyuysky Trakt”. Neleger (62º18’56.8” N, 129º29’55.0” E) is located approximately 50 km to the NNE of Yakutsk, whereas Vilyuysky Trakt (62º05’27.8” N, 129º21’21.3” E) is about 23 km to the ENE of Yakutsk (see Figure 4-1).

The trip to site Neleger consists of about 20 km of asphalt road and 30 km of dust road. Therefore, a four-wheel drive car is necessary to reach Neleger camp. The site is under supervision of scientific personnel throughout most of the time every year, and a camp with wooden houses including stolovaya (dining room), banja (sauna) and lednik (ice cellar), electricity and other facilities is available. The station is mostly used by Japanese scientists, who work on gas (CO_2) and water fluxes with, among other high-tech equipment, two eddy correlation towers and a meteorological station.

Vilyusky Trakt is a (mostly) paved road and the selected site near km 22.5 is easy to be reached by car. However, the site is used by many people for collection of mushrooms and cranberries and for picknicks. Therefore, the site is relatively unsafe for long-term measurements. Especially data loggers might attract interest of people casually passing by. Scientifically, it was important to gather information on frost cracking activity such as polygonal structures and frost cracks. A low vegetation cover and, especially, a thin active layer were expected to be most promising to find ice veins to be drilled in future field campaigns. Therefore, only two frost cracking experiments were established at Vilyuysky Trakt. The main part of the work, seven experiments in total, was carried out at Neleger. Both sites may be visited several times a year in order to check the experiments, sample snow profiles and observe changes.

4.1 Geological, Geographical and Meteorological Background

Alexander Dereviagin, Victor Kunitsky and Hanno Meyer

The Yakutsk area is characterised by the Lena River on which western side the city was build. Wide-spread river terraces dominate the landscape, which is under the influence of continuous permafrost. The first two Lena terraces are young, <12 ka, and 10-12 m and 15-17 m above present river level. Most prominent is the 6th Lena terrace (Magansk terrace), forming relatively steep cliffs on both sides of Lena River. This terrace is estimated to be more than 2 Mio years old and reaches a height of about 250 m or, accordingly, 160 m above river level. The height of the Magansk terrace at both working areas is about 220-225 m above sea level.

Table 4-1: Mean monthly air temperatures and precipitation for meteorological stations in Yakutsk and Magan.

station	height	months												year
	(m) a.s.l.	1	2	3	4	5	6	7	8	9	10	11	12	
		monthly air temperature (ºC)												
Yakutsk	99	-43.2	-35.9	-22.2	-7.4	5.7	15.4	18.7	14.8	6.2	-7.9	-28.0	-39.8	-10.3
Magan	210	-41.7	-33.3	-19.8	-7.5	4.9	14.8	18.0	14.1	5.7	-8.0	-27.4	-38.4	-9.9
		monthly precipitation (mm)												
Yakutsk	99	7	6	4	8	15	29	39	38	22	15	11	8	202
Magan	210	6	5	4	7	15	28	39	38	22	14	11	8	197

The trough-like structure of the landscape leads to temperature inversion. Cold air sinks to the lower reaches of Yakutsk, whereas at the 6th Lena terrace, the temperatures may be several degrees higher. Both working areas are located at the 6th Lena terrace, such as the NOAA meteorological station near Yakutsk in

Magan. The Yakutsk region is characterised by temperate continental climate with cold winters and warm summers. In Table 4-1, mean monthly air temperatures and precipitation of meteorological stations in Yakutsk and Magan are summarised.

The mean annual values of precipitation vary in wide range from 160 to 290 mm (Gavrilova, 1973), more than half of it being winter precipitation. A stable snow cover forms in October, whereas thawing starts in April. The most intensive melting is observed in May. The area is continuously covered by snow for a period of about 205-215 days per year. The mean thickness of snow cover reaches 30-40 cm, and mean density of snow varies from 0.12-0.14 g/cm^3 in the beginning to 0.22-0.25 g/cm^3 in the end of winter.

The climatic conditions have some specific features such as intensive processes of snow evaporation in spring. About 20% of the snow cover may evaporate during spring (Are, 1978). Another feature is the formation of a depth hoar horizon in the bottom part of the snow cover. Depth hoar is a type of snow with distinctive crystal shapes (Akitaya, 1974). Processes of snow metamorphism due to temperature gradients in snow cover can change the isotopic composition of fresh snow. The thickness of depth hoar horizon can reach 70-90% of the total thickness of the snow cover at the end of the winter. All these climatic features may influence the isotopic composition of the snow cover – being the base for ice wedge isotopic composition - and change it considerably.

The geological and geomorphological situation of these sites is determined by its location in the junction zone of two large tectonic structures: the Aldansk anticline and the Vilyuisk syncline. The bottom structural unit underlies Lena river level and consists of Cambrian carbonates, overlain by Mesozoic (Jurassic and Cretaceous) and Cenozoic terrigenic sediments (e.g. sandstones, auleurolites, loams, with layers of sand, coal, and gravels) with a total thickness of more than 800 m. The upper part of the Cenozoic structural unit is represented by Pliocene-Eopleistocene sediments of Solbansk and Tabaginsk suites composed of gray and yellowish sands with gravel. The total thickness of these sediments is about 30 m.

A thin cover of Pleistocene sediments overlies the older units: Khanchalinsk suite (sand with lenses of gravel) and the Late Pleistocene Ice Complex sediments (ice-rich aleurits with ice wedges).

^{14}C dating of these sediments show the Sartansk age of Ice Complex (Solov'ev, 1989, Grinenko et. al., 1995). The thickness of Ice Complex determined at the Neleger site in boreholes varies from 5 to 15 m. According to borehole data, the thickness of Ice Complex ice wedges can reach 10-15 m (Barygin et. al., 1966). Recent lacustrine and swamp sediments as well as sediments of alasses (thermokarst depressions) are locally distributed being composed of aleurits, silts and peat.

According to geothermal measurements in boreholes the thickness of the zone with negative rock temperature in this region is about 350-400 m (Balobaev, 1991). This zone consists of a zone of perennial frozen sediments with ground ice in the upper part and a zone of interpermafrost cryopegs (cryotic ground with brines) in the bottom. The mean ground temperature at the zero annual variation level is about -1.5°C to -3.5°C. Deep taliks (of more than 90 m) exist under lakes (for example, Lake Tuoydaakh, near site Neleger).

4.2 Investigations at Site *Neleger* and *Vilyuysky Trakt*

Hanno Meyer, Igor Syromyatnikov, Victor Kunitsky, Alexander Dereviagin and Radomir Argunov

The site **Neleger** is located at the 6th Lena terrace, about 62°19' N, 129°29' E and 225 m a.s.l. The taiga landscape is dominated by birch-larch-forests interrupted by large thermokarst depressions (alasses), which may reach diameters of a kilometer and more. In general, alasses are free of trees and characterised by grass vegetation. Within these depressions, pingos of up to 10 m in height are frequent. The active layer thickness varies between 0.5 m and 1.3 m depending on the site-specific characteristics. The taiga sites have a thinner active layer, whereas at the alass sites, summer heat may easier penetrate the soil and active layer thicknesses of up to 1.3 m were measured. In general, the polygons both at alas and taiga sites are not consisting of complete polygons, but of one or several frost cracks including triple junctions. The polygonal relief is low with maximum height variations between polygonal rim and polygon centre of 30 cm. As a consequence, the vegetation is similar for rim and centre of the polygon. In general, the polygon diameter is small and varies between one and three metres. Since the area around Neleger is characterised by these specific medium-sized landscape variations, frost cracking experiments were established both at taiga and at alass sites. This enables us to estimate the effect of site-specific characteristics (such as active layer thickness. permafrost temperatures. vegetation cover) on the timing of frost cracking as well as on the stable isotope composition of ice wedges.

Two sites in the alass about 1 km to the East Camp Neleger were selected (Alass 1 and Alass 2) as well as two sites in the forest: one 150 m N of Camp Neleger (Forest 1) and one in the forest 300 m to the west of the alass and about a km to the North of the Camp (Forest 2).

Site Alass 1

Site Alass 1 is located about 100 m NW of the lake and about 80 m E of the rim of the alass, where the forest begins (Figure 4-2). Single frost cracks are frequent. However, a complete polygon was not found. The active layer thickness was measured several times and varies between 0.95 and 1.3 m. The vegetation cover consists of grass (monospecific), which is harvested by local farmers.

At this site, a borehole was drilled for the establishment of a temperature profile. Three temperature loggers (type ESYS Temp 0.1) were installed at depths of 0.1m (Temp 11). 0.6 m (Temp 12) and 1.1 m (Temp 13), (compare Figure 4-4b). In the borehole, the thickness of the active layer was 1.25 m. For air temperatures, an additional temperature logger (Temp 14) was installed at the 2 m height. A sample of the recent vegetation cover and the uppermost part of the soil was taken for palynological analyses (Nel-AA-1). For this locality, frost cracking experiments N1A-N1B and N2A-N2B were installed with dataloggers Volt 11 and Volt 12, respectively. Since the experimental set-up is the same for all sites, the logging of the frost cracking process in detail can be drawn from Meyer (2003).

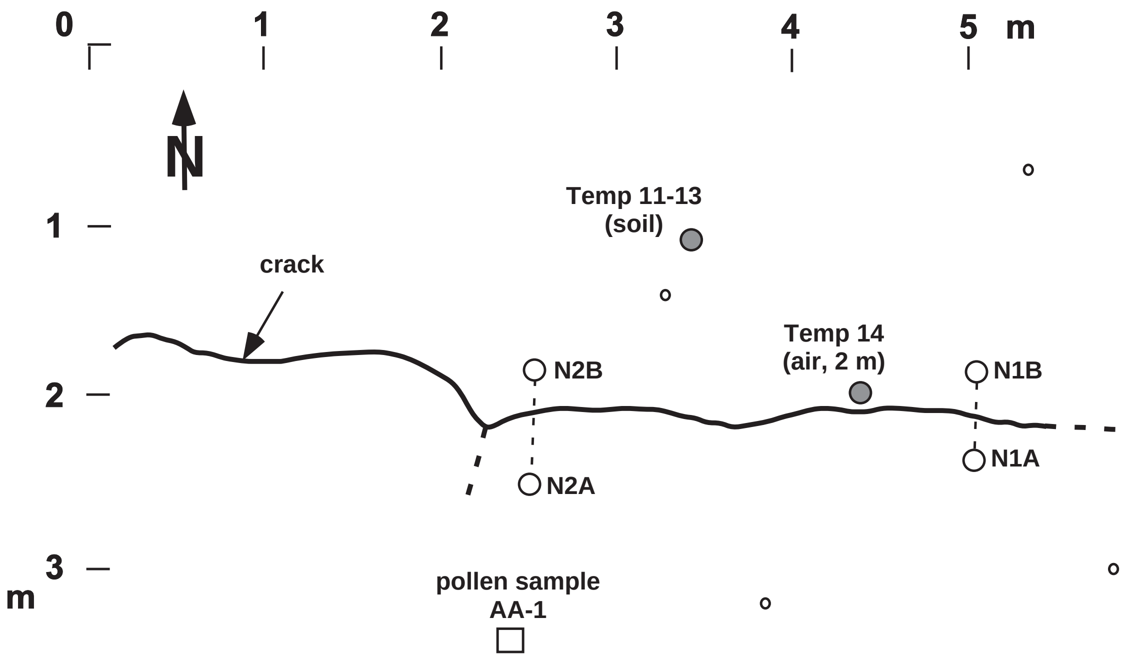

Figure 4-2: Experimental set-up for frost cracking experiments at site Alass 1.

Site Alass 2

This site is located in the same geomorphological situation as site Alass 1, about 100 m E of the lake and about 90 m W of the rim of the alas (Figure 4-3). Additionally to the same type of grass as near site Alass 1, meadow plants are sparsely distributed. The active layer reaches 0.9 to 1.2 m in thickness. The frost cracks are clearly visible and up to 3 mm wide. In total, three small hexagonal polygons with diameters of about 2.2 m were observed. The height difference in the relief is low with about 15 cm between the higher centre and the lower rim. However, these polygons are rather juvenile (compare Meyer, 2001) and no clear high-centre polygons. As at site Alass 1, the vegetation is not differentiated within the polygon and, here also, a sample of the vegetation cover and the upper part of the soil was taken for palynology (Nel-AA-2). For this locality, frost cracking experiment N3A-N3B with voltlogger (Volt 13) was installed.

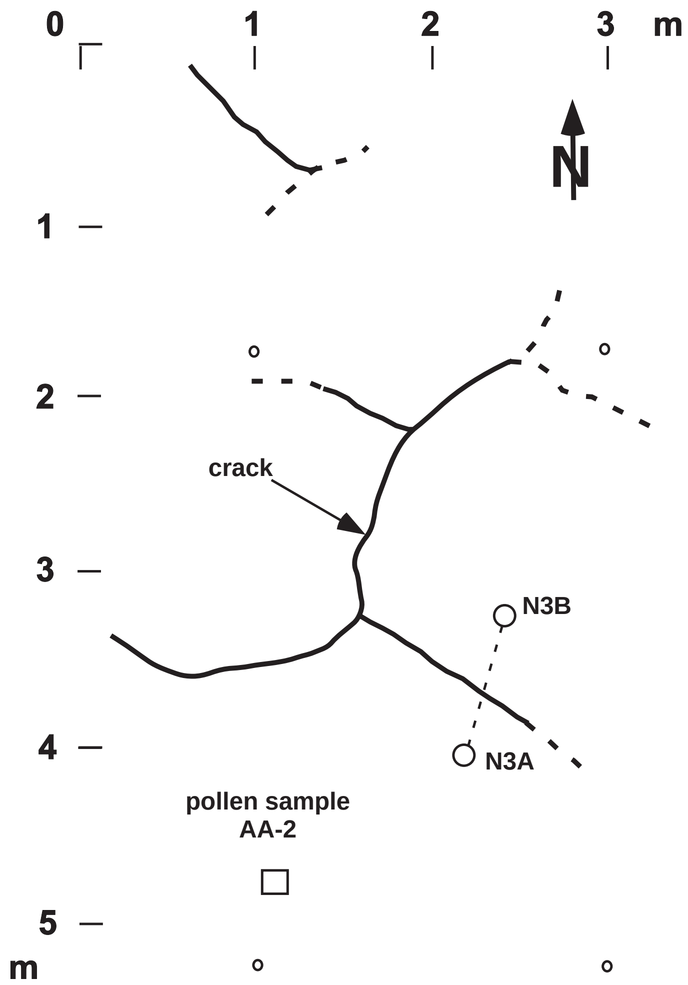

Figure 4-3: Experimental set-up for frost cracking experiments at site Alass 2.

Site Forest 1

The site Forest 1 consists of several small polygons (diameter about 2 m), with clearly visible troughs at the polygonal rims (Figure 4-4a). However, the polygonal structure is not as well developed as in site Alass 2. The relief is in general higher than in the Alass sites with maximum height differences of about 30 cm. The vegetation of this site near camp Neleger is mainly composed of larch trees, which may reach up to 15 metres in height, as well as few younger birch and larch trees, a type of grass and cranberries. The vegetation cover was sampled for palynology (Nel-AA-3).

A second temperature profile was installed in a 1.1 m deep borehole with three temperature loggers at respective depths of 0.1m (Temp 15), 0.5 m (Temp 16) and 0.9 m (Temp 17). In the borehole, the thickness of the active layer was 1.0 m. For air temperatures, an additional temperature logger (Temp 5) was installed in a height of 2 m. The active layer thickness was measured between 0.65 m and 0.85 m, in the borehole for the temperature profile slightly higher (1.0 m). At this site, frost cracking experiments N5A-N5B. N6A-N6B and N7A-N7B with respective dataloggers (Volt 15, 16 and 17) were installed.

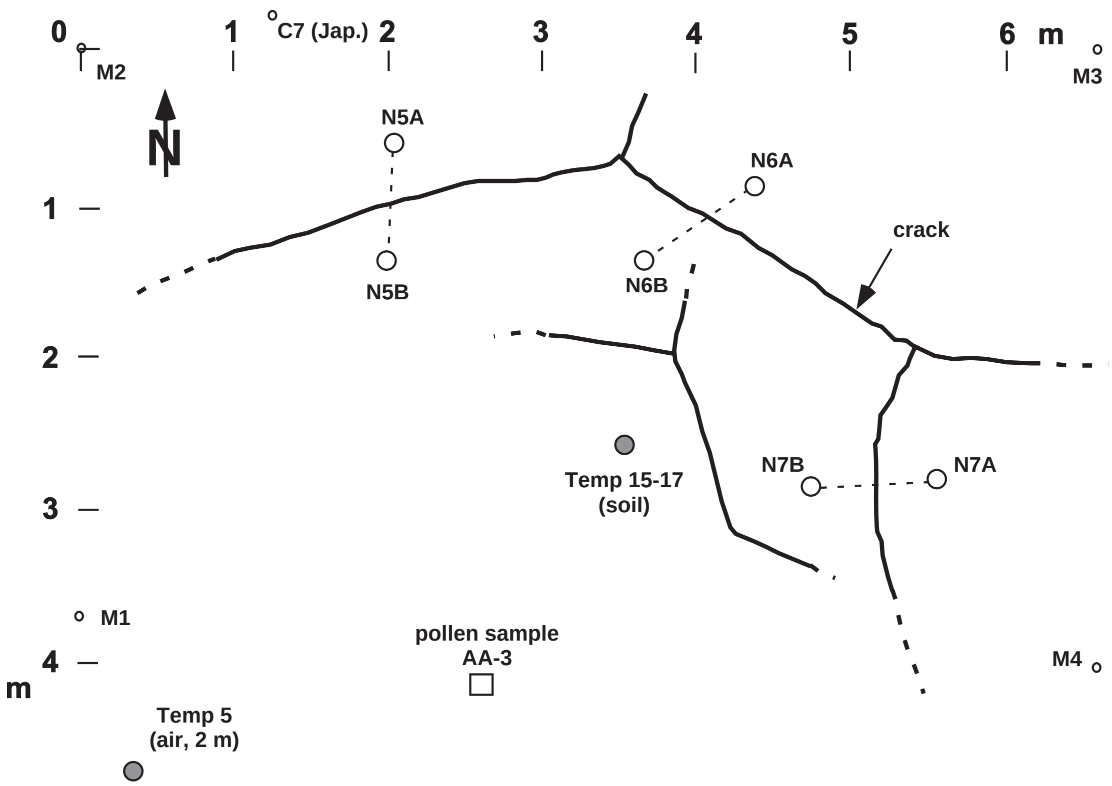

Figure 4-4a: Experimental set-up for frost cracking experiments at site Forest 1.

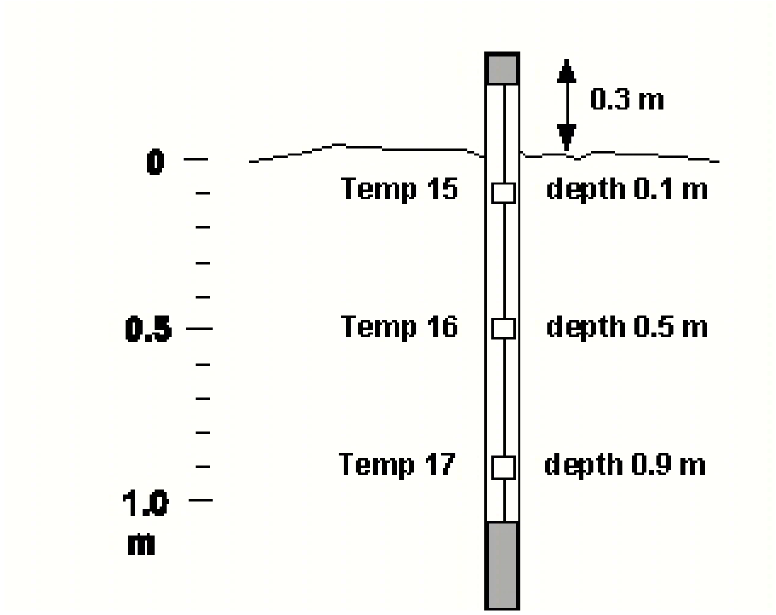

Figure 4-4b: Temperature loggers (Temp 15-17) and their respective depths installed at site Forest 1.

Site Forest 2

At location Forest 2, one single polygonal trough, about 18 cm wide and up to 20 cm deep, is observed (Figure 4-5). Apparently, two troughs, 65 and 120 cm long, respectively, are joint here with an angle of about 120° between them. Clear frost cracks or other polygonal structures are not evident. The active layer thickness is the lowest of all sites with 0.5 to 0.6 m. The relief is uneven and similar to site Forest 1 with height differences of about 30 cm. The site is located in a birch (>50%) –larch (<50%) forest. Additionally, dog roses and cranberries, a type of grass and mushrooms are common features. A peculiarity of this location is the evidence of a former forest fire, to be seen at the trunks of older trees. A palynology sample (Nel-AA-4) was taken at this site. Here, frost cracking experiment N4A-N4B with voltlogger (Volt 14) was installed.

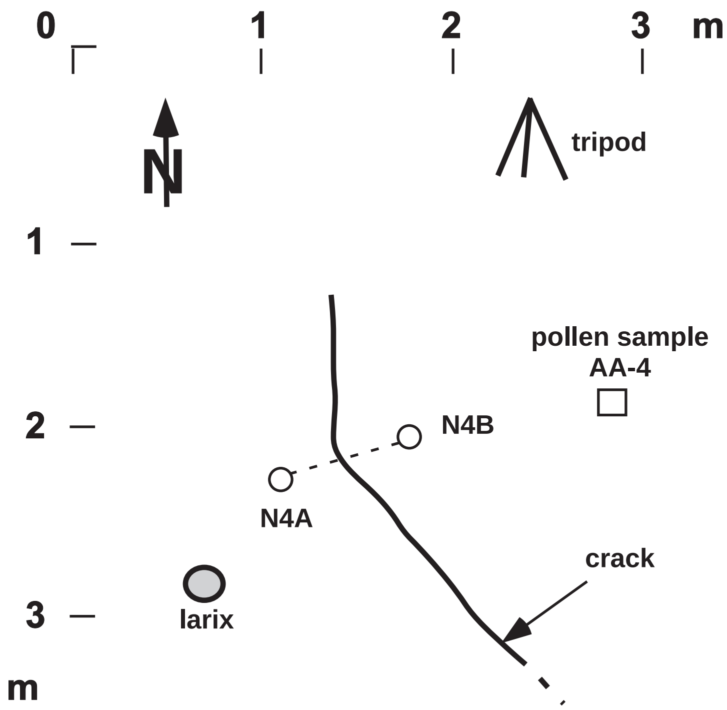

Figure 4-5: Experimental set-up for frost cracking experiments at site Forest 2.

Site Vilyuysky Trakt

The site **Vilyuysky Trakt** is located at N 62°05' and E 129°21' about 250 m a.s.l. also at the Magansk terrace. The taiga landscape is slightly north facing and dominated by larch-birch-forests. In general, the active layer thickness varies between 0.5 m and 1.0 m depending on the site-specific conditions. The polygons at this site are relatively small (reaching up to 3-4 m in diameter) and often incomplete, consisting of one or some polygonal troughs with triple junctions. The polygonal relief is medium with maximum height variations between polygonal rims and centres of about 80 cm.

Only two frost cracking experiments were established at a specific location at Vilyuysky Trakt. At this location, a 3 m long frost crack and polygonal trough was selected. The active layer thickness is the lowest of all sites with 0.5 to 0.6 m. The site is located in a larch (>80%) –birch (10%) –alder (<5%) forest. Additionally, cranberries, grass and mushrooms are common features. A peculiarity of this location is the evidence of a former forest fire, to be seen at the trunks of older trees. A palynology sample (VT-AA-5) was taken close to this site. Here, frost cracking experiments V8A-V8B and V9A-V9B with voltmeters (Volt 18 and Volt 19, respectively) were installed (Figure 4-6).

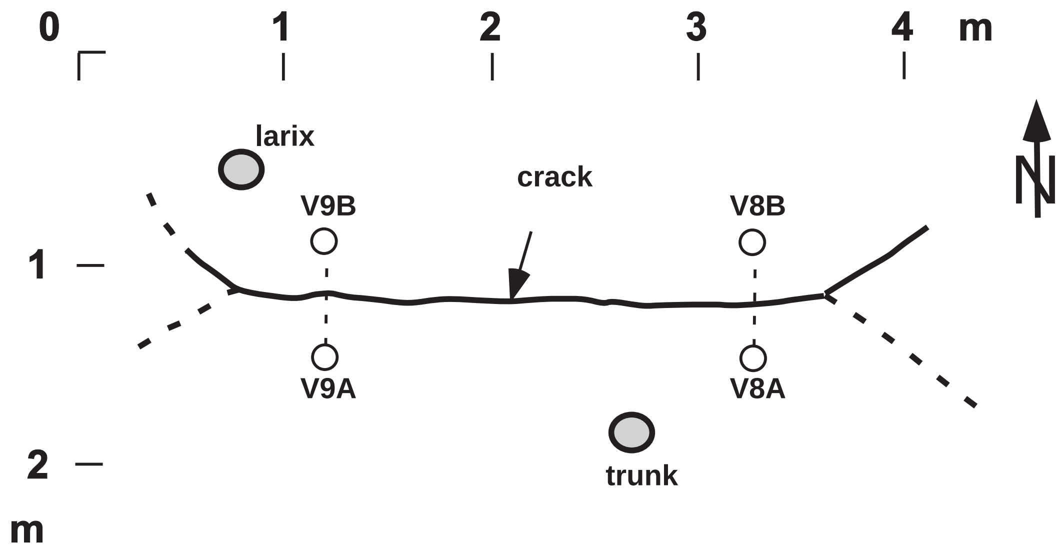

Figure 4-6: Experimental set-up for frost cracking experiments at site Vilyuysky Trakt.

Frost cracking experiments

For frost cracking experiments, two 1.5 m long steel poles (A and B) were inserted on both sides of a frost crack. Between the poles, a breaking cable (copper wire or copper wire two-braid) was installed, which is connected with a datalogger measuring electrical contact every 20 minutes. As long as there is a contact, a small voltage can be measured. When the contact is interrupted (i.e. by frost cracking), the loggers drop to a voltage of zero, which clearly defines this precise moment. The tension necessary to break every type of cable was tested. Especially for short cables, the tension applied until rupture of a cable was found to be well reproducible and to be dependent on the a) length L of the cable. b.) type of the cable and c.) applied tension. The tension of a cable was increased by counting the revs U (or turnarounds) of a nut M5 on a thread rod. The maximum tension of the Cu wire (0.5 mm) was found to be: L/U=10;

maximum tension of the Cu wire two-braid ($2x0.75mm^2$) was found to be: L/U=7.

The tension applied (about 70% of the maximum tension) as well as the distance between the poles at the top, at the height of a tape mark and at the bottom was measured before and after stretching the cables. The details of every single experimental set-up, the distances between the poles and lengths, type and applied tensions of every single breaking cable are summarised in Tab. 4-2 and Tab. 4-3 at the end of this chapter. A more detailed summary of this kind of experiments including figures can be found in Meyer (2003).

Table 4-2: Frost cracking experiments with applied cables and voltmeters, the lengths of the breaking cables between the poles A and B before stretching the cable (1) and after the cables were stretched (2). The tension of the wires was increased by counting the revs (or turnarounds) of a nut (type M5) on the thread rod. For every cable type, maximum revs were calculated according to its length by means of the breaking experiments. Based on this a relative tension is given in % - in general around 70%).

Marker	Voltmeter	Cable type	Cable length (21.8.04)		Diff.	Turn-arounds	Max.	Tension in %
			1	2				
N1A-N1B	**11**	Cu wire (0.5 mm)	314	325	-11	22	31	71
N2A-N2B	**12**	Cu two-wire braid (HO3VH-H, 2x0.75)	510	524	-14	43	63	68
N3A-N3B	**13**	Cu two-wire braid (HO3VH-H, 2x0.75)	384	395	-11	35	48	73
N4A-N4B	**14**	Cu wire (0.5 mm)	464	478	-14	38	46	83
N5A-N5B	**15**	Cu two-wire braid (HO3VH-H, 2x0.75)	386	391	-5	35	48	73
N6A-N6B	**16**	Cu wire (0.5 mm)	417	426	-9	30	42	71
N7A-N7B	**17**	Cu wire (0.5 mm)	458	470	-12	50	46	109
V8A-V8B	**18**	Cu wire (0.5 mm)	278	286	-8	20	28	71
V9A-V9B	**19**	Cu wire (0.5 mm)	275	283	-8	20	28	71

As on Samoylov Island in the Lena Delta, tracer experiments were carried out. For this, crystal violet coloured *lycopodium* spores were applied to the polygon trough of each experiment at sites Neleger and Vilyuysky Trakt (compare Chapter 3.10 and Meyer, 2003). In spring, when the snow cover melts, meltwater should transport the spores into the open crack. The spores are supposed to mark the newly formed ice vein, which may, thus, be attributed to the year of formation and subsequently sampled for stable isotope measurements.

Table 4-3: Ten stretching experiments with the respective distances (in mm) between the poles A and B measured from the a.) top to the top, b.) tape mark to the tape mark and c.) bottom to the bottom, after the cables were stretched.

Marker 2004 Neleger Vilyuysky Trakt	Distance (mm) Top-Top 1	2	Diff.	Distance (mm) Tape-Tape 1	2	Diff.	Distance (mm) Bottom-Bottom 1	2	Diff.
N1A-N1B	546	536	10	548	542	6	555	553	2
N2A-N2B	820	794	26	820	799	21	817	807	10
N3A-N3B	738	717	21	743	730	13	754	743	11
N4A-N4B	861	836	25	854	838	16	856	843	13
N5A-N5B	780	741	39	785	755	30	793	778	15
N6A-N6B	816	804	12	822	812	10	830	822	8
N7A-N7B	860	823	37	863	833	30	862	842	20
V8A-V8B	501	470	31	509	486	23	518	503	15
V9A-V9B	601	577	24	608	591	17	618	612	6

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6 Appendix

Weekly Reports (in German)

Wochenbericht Nr. 1, 24.05.2004

Am Donnerstag, dem 13. Mai 2004 begann die 2004er Ausgabe der Lena-Delta Expedition der Forschungsstelle Potsdam des Alfred-Wegener-Instituts (AWI). Ziel der Expedition ist die Insel Samoylov im sibirischen Lena-Delta, bei etwa 72° noerdlicher Breite und 126° oestlicher Laenge. Mit am Start sind diesmal: Lars Heling von der Universitaet Hamburg, sowie Guenter Stoof (Molo) und Christian Wille vom AWI Potsdam. Diese Besatzung wird bis etwa zum 23. Juni auf der Insel leben und arbeiten; insgesamt wird die Expedition bis Ende Juli andauern.
Die Arbeitsinhalte des ersten Expeditionsabschnittes sind: Aufbau des Eddy-Kovarianz-Systems zur Messung des turbulenten Stoff- und Energieaustausches zwischen Boden und Atmosphaere, Beobachtung des Auftauvorgangs des Permafrostbodens durch regelmaessige Messung von Schneehoehe bzw. Boden-Auftautiefe sowie Beschreibung und Beprobung von Schneeprofilen, Wartung der bestehenden meteorologischen und bodenphysikalischen Messstationen, Durchfuehrung von Haubenmessungen zur Bestimmung der Methanemission des Bodens, sowie die Entnahme von Eis- und Bodenproben fuer Laboruntersuchungen in Deutschland.

Die Anreise nach Samoylov erfolgte - mit einiger Verspaetung durch schlechte Sichtbedingungen im Lena Delta - am vergangenen Mittwoch mit einem Hubschrauber von der Nordmeerstadt Tiksi aus. Die ersten Tage haben wir damit verbracht, die vier Raeume im Stationsgebaeude des Lena-Delta-Reservates (eine Kueche, zwei Labore und ein Schlafraum) zu beziehen. 38 Kisten, 2 Generatoren und einige hundert Kilogramm Lebensmittel in Kartons mussten verstaut, ausgepackt, aufgebaut beziehungsweise eingeraeumt werden. Nach einigem Hin und Her hat nun alles seinen Platz gefunden (inklusive der Expeditionsteilnehmer); die Stromversorgung und Satellitenkommunikation funktioniert; Teller, Toepfe, Pfannen und der Gasherd sind am rechten Platz; und auch die etwas ungewohnteren haeuslichen Erledigungen wie das Hacken von Eis fuer die taegliche Trinkwasserversorgung sind fast schon Routine. Fuer den Mitteleuropaeer zeigt sich das Lena Delta noch winterlich: zum Zeitpunkt unserer Anreise war die Insel noch gaenzlich von Schnee bedeckt und die Temperaturen lagen bei etwa –5°C am Tag und bis zu –10°C in der Nacht. Allerdings sind das schon fruehlingshafte Temperaturen, wenn man bedenkt, dass unsere Messstation auf Samoylov im Februar eine Temperatur von unter –50°C (!) aufgezeichnet hat. In den letzten Tagen hat sich das Aussehen der Insel jedoch dramatisch veraendert: am Samstag stieg die Temperatur erstmalig in diesem Jahr ueber die 0°C-Marke und ein rasanter Tauprozess hat eingesetzt. Ueberall sind nun die moosbedeckten Waelle der Polygone sichtbar und der darunterliegende Boden beginnt, langsam aufzutauen – hoechste Zeit also fuer uns, die Instrumente aufzubauen um diesen spannenden Prozess zu beobachten. Wir werden davon berichten ...

Herzliche Gruesse,
Molo, Lars und Christian

Wochenbericht Nr. 2, 01.06.2004

Liebe Freunde der Expeditionsberichtserstattung,

obwohl ihn die Schneespatzen vom Dach des Stationsgebaeudes pfeiffend schon angekuendigt haben, laesst er immer noch auf sich warten, der Fruehling. Nachdem am vorvergangenen Wochenende die Temperatur verheissungsvoll die magische 0°C-Marke ueberschritten hatte, fiel sie am Beginn der letzten Woche wieder darunter, um dort zu verharren. So bescherten uns die vergangenen 7 Tage eine Durchschnittstemperatur von -4.2°C bei zeitweise starken oestlichen Winden und gelegentlichem Schneefall. Der rasante Auftauprozess kam nahezu zum Stillstand und die gemessene Schneehoehe in dem von uns beprobten Polygon verringerte sich im gleichen Zeitraum um nur 0.8 cm auf durchschnittliche 28.7 cm. Waehrend sich also die Schneebedeckung auf der Insel nur wenig veraenderte, sind dramatische Veraenderungen in der Umgebung zu beobachten: das von Sueden heran draengende

Wasser hat sich Wege an die Oberflaeche gesucht und bildet seit Samstag grosse Seen auf der etwa 2 Meter dicken Eisschicht der uns umgebenden Flussarme.

Den ueberwiegenden Teil der vergangenen Woche verbrachten wir im Felde mit dem Aufbau des Eddy-Kovarianz-Messsystems. Die Plattformen fuer die Gasanalysatoren, das Messzelt und den Generator wurden aufgespuert und von Schnee und Eis befreit. Dann wurden die Geraetschaften mit Hilfe von Sergej und seinem Buran (einem steinzeitlichen Skidoo) von der Station zum Messfeld transportiert. Dort wurden zuallererst der Generator in Betrieb genommen und das Zelt aufgestellt, damit die beim vorherrschenden eisigen Ostwinde schnell erstarrenden Fingerchen immer mal wieder am Heizluefter aufgewaermt werden konnten. Die restlichen Koerperteile wurden durch den roten Isolier-Strampelanzug der AWI-Kleiderkammer warm gehalten, der dadurch – wie auch schon waehrend der letztjaehrigen Expedition – wieder zu allen Ehren kam. Schritt fuer Schritt wurden so die Instrumente aufgebaut, verschlaucht und verkabelt, sodass am Freitag der Messbetrieb aufgenommen werden konnte. Zusaetzlich dazu begann Lars am Sonntag mit den taeglichen Hauben-Methanemissionsmessungen, sodass nun das Dauermessprogramm des ersten Fahrtabschnittes vollstaendig angefahren ist.

Natuerlich wurden auch im haeuslichen Bereich Fortschritte erzielt. Um der zeitraubenden Eisschmelzerei und der damit einher gehenden Ueberheizung unserer Wohnung ein Ende zu bereiten, wurde durch Molo eine Brunnenbohrung ins Eis des Banja-Sees niedergebracht. Nachdem 1.8 Meter Eis muehevoll von Hand durchbohrt worden waren, kam durch Braunalgen verschmutztes Wasser zu Tage, das lediglich fuer die aeusserliche Anwendung in der Banja verwendbar war. Eine zweite, von Sergej durchgefuehrte Bohrung war jedoch von Erfolg gekroent, und flugs wurden alle erdenklichen Gefaesse im Hause mit dem kostbaren Nass befuellt. Diese Vorratshaltung bietet bereits einen Vorgeschmack auf die Zeit des Fruehjahrshochwassers, wenn nach Angaben der Hiesigen fuer etwa zwei Wochen alles Oberflaechenwasser verschmutzt sein wird. Fuer besagtes Hochwasser und den damit verbundenen Eisgang sind bereits weitere Vorbereitungen getroffen worden: Sergej hat uns ueber die notwendigen Vorsichtsmassnahmen belehrt und zusammen haben wir zwei motorisierte Aluminiumboote an den Eingaengen des Stationsgebaeudes festgemacht. Uns plagt natuerlich nun die Frage, wann es kommen wird, das Hochwasser. Aber es ist wie immer: nichts genaues weiss man nicht. Nur Olga behauptet felsenfest, das Wasser wuerde am 19. Juni kommen. Sie hat das nun mal im Gefuehl. Aber was wir von den einheimischen Wetterfroeschen zu halten haben, haben wir ja waehrend der letzten Jahre gelernt ...

Hoch und trocken (noch), und wachsam,
mit herzlichen Grüßen,
Lars, Molo und Christian

Wochenbericht Nr. 3, 07.06.2004

Werte Leser, liebe Angehoerige, Kollegen und Lieblingsmenschen,

mit dem heutigen Tag scheint der Fruehling endlich Einzug ins Lena Delta gehalten zu haben. Bei unglaublichen +1.5°C, strahlendem Sonnenschein und einer leichten Brise aus Suedost rissen sich alle Expeditionsteilnehmer um die Aussenarbeiten. Hatte uns doch die vergangene Woche in Bezug auf das Wetter noch einmal einiges abverlangt: Die Durchschnittstemperatur lag wie auch in der Vorwoche bei -4.2°C, und die meisten Tage waren durch starken Wind aus noerdlichen Richtungen gepraegt.
Trotz der Minusgrade nagten Wind und Sonne an der Schneedecke, und so fiel in der ersten Haelfte der Woche die durchschnittliche Scheetiefe auf unserem Messfeld von 28.4 auf 23.7 Zentimeter. Das Wochenende brachte jedoch kraeftigen Schneefall und auf diese Weise sind noch immer etwa 80 % unserer Insel mit Schnee bedeckt. Die widrigen Witterungsverhaeltnisse veranlassten "Mr. Hatz", den Stromversorger des Eddy-Systems dazu, die Aermel nochmals so richtig hochzukrempeln. Schon im letzten Herbst verlor er seine Auspuffverkleidung. Das schien ihm jedoch nicht genug des Einsatzes fuer die Wissenschaft gewesen zu sein, und beim gestrigen Kontrolltermin lag der Auspuff selbst im Schnee. Hoffen wir, dass es demnaechst nicht der Zylinderkopf sein wird, und dass Mr. Hatz uns weiterhin zuverlaessig mit Elektrizitaet versorgt.

In der vergangenen Woche waren wiederum grosse Veraenderungen auf den Armen der uns umgebenden Lena zu beobachten. Genau genommen warten wir ja noch auf sie, die Lena. So jedenfalls geht die Redewendung der Einheimischen, die darunter den derzeitigen Stand des Eisganges und des damit verbundenen Hochwassers verstehen. Innerhalb der letzten Woche ist der Wasserstand bereits um 2-3

Meter gestiegen und hat das Eis in grosse Schollen aufbrechen lassen. Weite Bereiche der uns umgebenden flachen Inseln sind ueberschwemmt, und so sieht es aus, als laege Samoylov inmitten eines grossen Sees. Die rege haeusliche Geschaeftigkeit widmete sich denn auch der Vorbereitung der bevorstehenden Fluten. Bei einer Katastrophenschutzuebung wurde die Tauglichkeit unserer motorisierten Rettungsboote vom Typ "KASANKA 5" getestet. Bei Mitnahme nur der noetigsten Waschartikel erwies sich das Platzangebot als ueppig; die gute Aussicht von allen Plaetzen wurde gelobt, der Sitzkomfort wurde jedoch bemaengelt.
Das in Form von angeschwemmten Baumstaemmen reichlich vorhandene Feuerholz wurde gesaegt, gehackt und an sicheren Orten verwahrt, damit es von der Lena nicht aufs Meer getragen werde. Die Schneespatzen bezogen die neuen Holzstapel sogleich in ihre Nistplatzsuche mit ein. Ueberhaupt zeigt sich auf Samoylov eine aus den Sommermonaten nicht gekannte Artenvielfalt und Menge von Voegeln aller Art. Fuchs und Hase wurden ebenso gesichtet.
Schliesslich wurde nach den erfrischenden Erfahrungen der letzten Wochen die Installation einer heizbaren Klobrille in Betracht gezogen, musste aber aus arbeitsschutztechnischen Gruenden verworfen werden. So blieben die Besuche auf "Villa Sonnenschein" auf ein zeitliches Minimum beschraenkt und das Lesen der oertlichen Presse blieb vollends aus. Zum Glueck gibt es als Ausgleich das Schwitzen in der samoylovschen Sauna bei milden 104 °C - wie immer ein Hochgenuss ...

Nicht mehr ganz so Hoch ueber den Fluten, aber immer noch trocken,
mit herzlichen Grüßen,
Lars, Molo und Christian

PS: Ganz frisch aus dem Ticker: Der Eisgang soll bereits die etwa 40 km stromaufwaerts gelegene Siedlung Tit-Ari erreicht haben. Die Spannung steigt ...

Wochenbericht Nr. 4, 15.06.2004

Liebe Expeditionswochenberichtsleser,

die Lena ist gekommen! Am vergangenen Donnerstag konnten wir unter recht spektakulaeren Umstaenden erfahren, was Hochwasser und Eisgang bedeuten. Nach den Meldungen ueber das nahende Eis vom Montag Abend wurde dieses bereits am Dienstag Morgen durch entferntes Rauschen und Grummeln hoerbar. Im Verlauf der folgenden Tage konnten wir beobachten, wie auf dem Hauptstrom der Lena in einigen Kilometern Entfernung die Eisschollen zusammen geschoben wurden und sich zu grossen Huegeln auftuermten.
Am Donnerstag Mittag war es dann soweit: nachdem durch die Eismassen in der naeheren Umgebung der Insel ein Rucken und Knistern gegangen war, begann der Wasserstand ploetzlich rasant zu steigen. Olga erschien sofort auf dem Schlachtfeld, und begann, Befehle zu erteilen. Molo und Sergej schluepften in die Watstiefel, um aus dem Lednik (Eiskeller), der von der Station durch ein Baechlein getrennt ist, noch schnell einige Vorraete zu holen. Lars und Christian bewaffneten sich mit Eimern und fuellten alle auffindbaren Gefaesse mit Wasser aus dem Eisbrunnen des Banja Sees. Innerhalb von etwa einer Stunde stieg der Wasserstand um knapp 2 Meter und verwandelte das Baechlein hinter der Station in einen ca. 15 Meter breiten reissenden Fluss, der den Banja See und mehrere dahinterliegende Seen flutete. Mit dem Wasser setzten sich riesige Mengen Eis in Bewegung, die an der Westseite der Insel im Bereich unseres Badestrandes anlandeten. Dabei pfluegten tonnenschwere Eisschollen durch das Steilufer; einige maechtige Schollen wurden auf das Plateau gehoben. Das alles dauerte nur etwa eine Stunde, danach lag unsere Insel – deutlich verkleinert und mit Eis verziert – wieder ruhig im Sonnenschein. Fuer den Kontrollgang zum Eddy-Messsystem musste am Abend ein grosser Umweg in Kauf genommen werden, aber bereits in der darauffolgenden Nacht fiel der Wasserstand um etwa 1.5 Meter, sodass unsere Arbeitsgebiete wieder problemlos erreichbar waren.

Die vergangene Woche zeigte sich mit einer Durchschnittstemperatur von + 0.6 °C insgesamt fruehlingshafter als die Vorwochen, wenn auch noch nicht enthusiastisch. Am Dienstag fiel der erste Regen der Saison, welcher den Tauprozess kraeftig voran brachte. Innerhalb eines Tages fiel die mittlere Schneebedeckung in dem von uns beprobten Polygon von 23.1 auf 10.7 cm. Mittlerweile ist der Schnee in unserem Polygon gaenzlich verschwunden, die Schneebedeckung auf der Insel ist auf unter 10% gefallen. Die Voegel wissen, was Sache ist, und haben mit alle Kraft ihr Balzgeschaeft begonnen. Um nicht untaetig daneben zu stehen, haben wir am Sonntag zu einem Subbotnik aufgerufen. Um die Station wurde gruendlich aufgeraeumt, Entwaesserungsgraeben wurden gebuddelt, und der Weg zum Klo von Resteis befreit. Jetzt warten wir darauf, dass die Sonne uns den Blumenschmuck dazu spendiert …

Mit herzlichen Grüßen in die Heimat,
Lars, Molo und Christian

Wochenbericht Nr. 5, 21.06.2004

Liebe Leser,

in der letzten Woche blieben wir weitgehend von Hoehepunkten verschont. Gleiches galt fuer die Temperatur, die in den vergangenen 7 Tagen ein Mittel von + 0.7 °C erreichte und damit den Wert der Vorwoche um nur 0.1 °C uebertraf. Ein kalter Wind aus Ost zwang uns, die mit einer gewisssen Erleichterung bereits abgelegten wollenen Unterhosen noch einmal hervorzuholen. Nichtsdestotrotz ging der Wandel der Jahreszeiten unaufhaltsam voran. Der Schnee ist nun vollstaendig verschwunden und der Auftauprozess des Bodens macht messbare Fortschritte. Die Pflanzen haben mit der Photosynthese begonnen und die Eddy-Kovarianz-Messungen zeigen einen stetig steigenden Fluss von Kohlendioxid aus der Atmosphaere in Richtung Boden. Am gestrigen Sonntag schwamm das noch vor unserer Haustuer festsitzende Eis davon. Das erste Boot der Saison machte an unserer Insel halt und ueberbrachte als Gastgeschenk eine Portion Salzheringe. Ein erstes zartes Bluemlein – ein Vergissmeinnicht – wurde gesichtet und von uns ausgiebig bewundert. Die Voegel haben die Balz weitgehend abgeschlossen, mit dem Brutgeschaeft erwarten sie nun die sprichwoertlichen Muehen der Ebene.
Dieser fuenfte Wochenbericht bezeichnet das Ende des ersten Abschnittes unserer Expedition. Dies zu wuerdigen, fand am gestrigen Sonntag eine Abschiedsfest statt, zu dem wir Sergej und Olga eingeladen hatten. Der diesjaehrige uebermaessig lange und harte Winter wurde noch einmal ausgiebig diskutiert und sein Ende ausgelassen gefeiert. Morgen wird Christian die Heimreise antreten. Am Ende dieser Woche werden sechs deutsche und russische Wissenschaftler die Besatzung auf der Trauminsel verstaerken und das wissenschaftliche Sommerprogramm in Angriff nehmen. Aber darueber im naechsten Bericht mehr ...

Mit herzlichen Grüßen in die Heimat,
Lars, Molo und Christian

Wochenbericht Nr. 6, 07.06.2004

Werte Leser, liebe Angehörige, Kollegen und Lieblingsmenschen,

nun ist es so weit, der zweite Fahrtabschnitt der diesjährigen Expedition ins Lenadelta hat an diesem Wochenende mit dem Eintreffen weiterer sieben Forscherseelen (Daria, Ira, Katya, Sascha, Grisha, Andreas und Dirk) begonnen, nachdem Christian Team 1 (Molo und Lars) verlassen hat um seine Heimreise anzutreten. Das bisher doch eher stille Leben auf der Trauminsel Samoylov wich einem emsigen Treiben. Der vielen gewohnte Anblick der Station mit einigen Zelten vor dem Haus ist wieder hergestellt und die Polygonlandschaft wird nicht nur durch die zunehmende Blumenpracht farbenfroher, weitverbreitet ist zur Zeit auch die orange AWI- Regenbekleidung („Müllfahrerkombi“). Leider führten Nachrecherchen des Sicherheitspersonals in Berlin-Tegel dazu, dass eine wichtige Transportkiste nicht zum Zielflughafen Moskau-Domodedovo transportiert wurde und dort bei den Expeditionsteilnehmern Dirk, Andreas und Daria für großen Frust sorgte. Nach großen Bemühungen vor allem unseres Moskauer Partners Sascha Dereviagin ist die besagte Kiste mit wertvollem technischem Gerät mittlerweile in Moskau eingetroffen und wird mit dem nächsten Flug nach Tiksi transportiert.
Mit der Ankunft der neuen Expeditionsteilnehmer wurde das Wetter im Delta immer besser und man konnte den Berichten der vergangenen Wochen über die dort geschilderten unfreundliche Wetterlagen kaum Glauben schenken. Der gestrige Morgen ließ uns den Arbeitstag bei milden 20°C freudig beginnen. Ein sehr starker Luftdruckabfall im Verlaufe des Nachmittags sorgte dann dafür, dass heute Schneeflocken bei mäßigem Nordostwind durch die Tundraluft wirbelten. Noch haben wir jedoch genug Holz vor dem Haus, und in solchen Fällen sorgt der schon oft gelobte russische Ofen für wohlige Wärme nach durchfrorenem Arbeitstag. An den letzten Tagen brachte die Lena zur Abwechslung einmal wieder reichlich Eis und Holz mit sich, das Serjoga unser Hausherr, dann aus seinen schon aufgestellten Fischernetzen bergen musste. Frischfisch gab es keinen, damit ist erst in den nächsten Tagen zu rechnen.

Auf dem Weg durch die Tundra machen Vögel in ungeahnter Artenvielfalt sehr häufig auf ihren anscheinend außerordentlich schlechten Gesundheitszustand aufmerksam, um von ihrem Gelege abzulenken. Ganz anders die Seeschwalben in zwar geringer Population, aber angriffslustig wie keine andere Möwenart hier im Delta, und immer wieder laufen einem eiskalte Schauer beim Ertönen ihrer Schreie über den Rücken, und ganz besonders denen, die mit dieser Spezies schon einmal Bekanntschaft machen durften.
Die neue Crew, allen voran Dirk, Andreas und Daria haben das Gelände zwischenzeitlich inspiziert und Vorbereitungen für eine geodätische Vermessung eines Polygons begonnen, an dem das gemeinsame wissenschaftliche Programm (Stressversuche, Diversitätsstudien und Tracerexperimente) durchgeführt werden sollen. Auch der Gaschromatograph für die Methanmessungen wurde trotz fehlendem Verbindungskabel in Gang gebracht und steht nun für die von Lars genommenen und von Daria noch zu nehmenden Emissionsproben zur Verfügung. Die bisherigen Untersuchungen zu den Stoff- und Energieflüssen laufen planmäßig weiter.

Mit herzlichen Grüssen in die Heimat,
Daria, Molo, Lars, Andreas & Dirk

Wochenbericht Nr. 7, 05.07.2004

Werte Leser, liebe Angehörige, Kollegen und Lieblingsmenschen,

die erste Woche des zweiten Fahrtabschnitts ist beendet und noch immer, wir haben schon Juli, sind die Ufer der uns umgebenen Inseln eisbedeckt, die Lena trägt nach wie vor vereinzelt Eis und Holz an unserer Trauminsel vorbei, der Wasserstand ist für diese Zeit außergewöhnlich hoch und die Jungforscher (early stage scientists) haben sich problemlos in das Gruppenleben integriert. Die Arbeitsaufgaben sind verteilt und das Bereiten des Frühstücks wurde zur täglichen unproblematischen Routine. Bei der letzten Permafrosttiefen-messung konnte eine mittlere Auftautiefe von nun schon immerhin 16,4 cm ermittelt werden und erste schlüpfende Mücken, unsere sehr wahrscheinlichen Plagegeister der nächsten Wochen, wurden in den Polygonseen gesichtet. Der gestrige Sonntagsspaziergang offenbarte es dann auch: Erste aber zur Zeit noch harmlose Flugobjekte der Spezies „Lenadeltakampfmücke“ an der NO-Küste Samoylovs in der Luft. Im Zelt konnte die Mückendichte erstmals mit „1“ festgestellt werden. Erste Anzeichen für einen eventuell doch noch zu erwartenden Sommer. Immerhin ist die Wassertemperatur der Lena schon seit einigen Tagen zweistellig, lädt bislang aber noch nicht zum Bade. Grund kann natürlich auch sein, dass die wirklich harten Mädels und Burschen es in diesem Jahre vorziehen den Sommer in wärmeren Gefilden zu verbringen, oder einfach nur den durchwachsenen Sommer in deutschen Landen genießen möchten.
Die Frischfischversorgung läuft in diesem Jahre immer noch nicht so reibungslos wie man es von vorangegangenen Expeditionen kennt. So etwas wie in diesem Jahre gab es wie so vieles Andere auch noch nicht. Normalerweise werden hier die ersten frischen Fische Anfang Juni verspeist, doch bislang lohnt es kaum die Netze in den Strom zu stellen, da neben Unmengen von Treibgut sich kaum ein Fisch verfängt, der die tägliche Speisekarte bereichern könnte.
In dieser Saison konnte erstmals die Methanfreisetzung mit beginnender Schneeschmelze, die in diesem Jahr recht spät am 30. Mai einsetze, an unserem seit 1998 etablierten Dauermessfeld quantifiziert werden. Eine detaillierte Auswertung steht noch aus, aber dennoch lassen die ersten Messwerte einen interessanten saisonalen Effekt vermuten: Der Polygonwall ist während des arktischen Sommers aufgrund der Drainage ins Polygonzentrum durch trockene und aerobe Bedingungen im Oberboden gekennzeichnet und zeigt daher normalerweise nur eine geringe Methanfreisetzung von durchschnittlich 10 mg CH_4 m^{-2} d^{-1} im Gegensatz zum Polygonzentrum, das Werte von bis zu 120 mg CH_4 m^{-2} d^{-1} erreichen kann. Während der Schneeschmelze, die auf dem Wall beginnt, ist der nur gering aufgetaute Boden des Polygonwalls wassergesättigt wodurch er eine deutlich stärkere Methanemission als im weiteren Verlauf des Sommers zeigt. Diese bisher nicht berücksichtigte Veränderung in der Methanemission stellt einen weiteren wichtigen Baustein zur Validierung des von uns geplanten Methanemissionsmodels für Permafrostböden dar.
Trotz der immer noch zu kalten Witterung ist die Stimmung im gesamten Team weiterhin gut, sodass wir uns auf die weiterführenden in-situ-Experimente freuen, deren Vorbereitungen auf Hochtouren laufen.

Mit herzlichen Grüssen in die Heimat,
Daria, Molo, Lars, Andreas & Dirk

Wochenbericht Nr. 8, 12.07.2004

Werte Leser, liebe Angehörige, Kollegen und Lieblingsmenschen,

da die beiden Teams sich im Vorfeld schon miteinander vertraut gemacht hatten, wurde es versäumt die einzelnen Expeditionsmitglieder der Forschungsstation Samoylov im Detail vorzustellen, was an dieser Stelle nachgeholt werden soll:
Zum Team 1 gehören (seit 20.5. auf der Station):
Günter Stoof (Molo), AWI Potsdam, Ingenieur
Christian Wille, AWI Potsdam, Ingenieur (hat wie geplant am 20.6. die Station verlassen
Lars Heling, Uni Hamburg, Geologiestudent (Diplomand)

Zum Team 2 gehören (seit 25.6. auf der Station):
Dirk Wagner, AWI Potsdam, Geomikrobiologe
Daria Morozova, AWI Potsdam, Geomikrobiologin (Doktorandin)
Andreas Gattinger, GSF Neuherberg, Bodenökologe
Grigoriy Fedorov, AARI St. Petersburg, Geomorphologin
Irina Fedorova, St. Petersburg State University, Hydrologe
Alexander Makarov, St. Petersburg State University, Geologiestudent

Nun haben wir auch schon das Bergfest des zweiten Fahrtabschnitts hinter uns. Der Blick aus dem Fenster offenbart es, Mücken an den Scheiben, wir haben Sommer. Samoylov ist weitgehend eisfrei, vereinzelt sind noch Schollenreste im Uferbereich vorzufinden, das gegenüberliegende Ufer ist jedoch immer noch von Eis bedeckt und in Stromesmitte bewegt sich Eis in Richtung Meer. Die Wassertemperaturen der Lena sind bei 16 °C angelangt und lockten am gestrigen Sonntag schon mal zum Bade, was dann nach dem Erklimmen des Stolb, einem Fels inmitten der Lena eine doppelte Erfrischung war. Seit der Saunasee seine Eisbedeckung abgelegt hat, stieg auch seine Temperatur rasant an und ist jetzt bei 15 °C angelangt, was nach dem Saunagang schon fast keine Erfrischung mehr.
Zu einer guten Tradition wurde es während des zweiten Fahrtabschnitts den etwas älteren Kollegen den Sonntagskaffee und das dazugehörige Frühstücksei ins Zelt zu bringen. Von dieser Stelle sei den Initiatoren allerherzlichsten Dank gezollt.
Vom Wetter her gestaltete sich die letzte Woche eher durchwachsen: Zu Beginn bestens, dann 10°C, Temperatursturz und Dauerregen. Letzterer veranlasste vereinzelte Forscher Schutzgräben durch den Tundraboden zu ziehen und somit den Unmut der Hausherrin heraufzubeschwören, was Rekultivierungsmaßnahmen größeren Ausmaßes nach sich zog. Mit dem Wochenende besserte sich das Wetter wieder und wir können dennoch erst eine geringe bis mittlere Mückendichte verzeichnen. Gut für uns und unsere Arbeit. Das Moskitohemd liegt bislang noch gut verpackt, jedoch in Reichweite. Es grenzte an ein Wunder, würden wir es in diesem Jahre ungenutzt und unverschmiert zurückbringen.

Seit geraumer Zeit hat eine Ente unmittelbar hinter unserer Station ihr Nest angelegt und sich weder von den letzten Stürmen und Regenfällen stören lassen, noch durch die Aufräumarbeiten auf der katastrophal zurückgelassenen Baustelle der Stationserweiterung (dazu mehr im nächsten Wochenbericht...).
Besonders verwunderlich ist, dass auch die sich stetig wiederholenden, neugierigen und prüfenden Blicke vieler Expeditionsteilnehmer unser Entlein vom Bebrüten ihrer neun Eier nicht abhält. Am heutigen Morgen soll das Klopfen der Kleinen an den Eierschalen schon deutlich vernehmbar gewesen sein und der erfolgreichen Aufzucht der Kleinen scheint in unmittelbarer Stationsnähe und somit im Schutze vor den Raubmöwen nichts im Wege zu stehen.
Am vergangenen Freitag war es dann wieder da, das ungute Gefühl. Ein unangekündigter Hubschrauber der Grenztruppen über Samoylov. Ein solcher brachte uns im letzten Jahr wegen unzureichender Genehmigungen nach Tiksi zum Verhör, jedoch nicht zurück. Jetzt war der Dokumentenberg ausreichend hoch und binnen einer Stunde konnten wir unseren gewohnten Arbeiten wieder ungestört nachgehen.

Die mittleren Auftautiefen der Untersuchungs-Polygone sind inzwischen durch die bereits beschriebenen sommerlichen Temperaturen weiter vorangeschritten und betragen zur Zeit im Wall 20cm und im Zentrum 15cm. Das fortschreitende Auftauen der Permafrostböden ermöglichte uns weitere geplante Prozessstudien durchzuführen. So wurde beispielsweise eine in-situ-Anreicherung der Methan produzierenden Mikroflora (Archaeen) gestartet. Mit diesem Ansatz wollen wir kälteliebende methanogene Bakterien isolieren, von denen es bisher weltweit nur sechs Isolate in Reinkultur gibt. Anhand dieser Kulturen können wir das physiologische und biotechnologische Potential bezüglich der Methanbildung und -freisetzung sowie der Kältetoleranz studieren. Für dieses Experiment wurden

spezielle Diffusionskammern mit einer semipermeablen Membran (Dialyseprinzip) in Potsdam hergestellt, sodass die Mikroflora in dem eingefüllten und mit Nährlösung versetzten Bodenmaterial mit dem natürlichen Habitat korrespondieren kann. Dadurch soll der schwierige Schritt der Anreicherung von kälteangepassten Bakterien erleichtert werden.
Ferner wurde im Rahmen des von der DFG geförderten Projektes „Tolerance Limits of Methanogenic Archaea in Terrestrial Permafrost“ erste Stressexperimente zur Salztoleranz der Methan bildenden Bakterien durchgeführt. In diesem Projekt wird Permafrost, wie er im Lenadelta vorzufinden ist, als terrestrischer Vergleichsstandort für Permafrost genutzt, wie er beispielsweise auf dem Mars existiert. Hierbei dienen die im Mittelpunkt unserer Forschung stehenden methanogenen Bakterien als Schlüsselorganismen für mögliches extraterrestrisches Leben. Methanogene Bakterien, die am Anfang des Lebens auf der Erde standen, sind geeignete Studienobjekte aufgrund ihrer besonderen Stoffwechseleigenschaften und Stresstoleranz.

Mit herzlichen Grüssen in die Heimat,
Daria, Molo, Lars, Andreas & Dirk

Wochenbericht Nr. 9, 19.07.2004

Werte Leser, liebe Angehörige, Kollegen und Lieblingsmenschen,

der letzte Wochenbrief dieser Saison von der Insel Samoylov. Nach Plan werden wir uns in einer Woche in Tiksi, der Stadt am Eismeer hinter dem Polarkreis, befinden. Die Zeit verging wie im Fluge. Den erhofften Sommer gab es nur sporadisch. Der Sonne gelang es noch immer nicht die Eisablagerungen des Frühjahrshochwassers vollständig abzuschmelzen. Nach einer kurzen zweistündigen Mückenplage vor zwei Tagen bewegen sich die Lufttemperaturen zum Wochenende wieder im unteren einstelligen Bereich. Dazu gibt es schneedurchwachsene Regenschauer und starken Nordostwind. Letzterer ermöglicht über den Umweg des Windgenerators für eine störungsfreie Stromversorgung unserer gemütlichen Hütte. Der Ofen, gleichzeitig Küchenherd, sorgt für wohlige Wärme, die an diesen Tagen nach Feldaufenthalten genüsslich aufgesogen wird.
Aber es gibt auch besonders gute Tage auf Samoylov, welche kompromisslos genutzt werden müssen. So gelang es uns in diesem Sommer erstmalig vor zwei Tagen am Lagerfeuer zusammenzusitzen. Der Strand war inzwischen schon so breit, dass er zwei zusätzliche Gäste, Volodja Posniakow und seinem Kollegen Jury, beide Ornithologen vom Lenadeltareservat, die wie aus dem Nichts rechtzeitig aus den Weiten des Deltas mit ihren Booten herbeieilten, zu beherbergen. Mücken gab es an diesem Tage wie bereits erwähnt nur an einigen wenigen Stunden des Vormittags und so stand dem Genusse gegrillten Rentierfleisches und einiger Gläschen Vodka nichts mehr im Wege.
Am Dienstag letzter Woche in den Vormittagsstunden wurde unsere Stationsente, leider immer noch namenlos, unser und unseren neugierigen Blicken überdrüssig und verließ die relativ sichere Stationsumgebung mit sieben Jungenten (early stage ducks) im Gefolge in Richtung Tundra und ward bis auf weiteres nicht mehr gesehen.
Unsere Sauna wurde schon oft erwähnt, doch wahrscheinlich noch nie beschrieben und eigentlich heißt sie im Russischen ja auch Banya. Man stelle sich eine Hütte an einem kleinen See vor, durch einen Steg mit selbigem verbunden. Rundum Natur pur, im Sommer farbenprächtig blühende, waldlose Tundra. Im Hintergrund Stolb, der schon früher erwähnte prägnante Fels in den Fluten der Lena, und die die Lena östlich begrenzenden Gebirgszüge. Schon der Eingang gebietet Vorsicht. Die Räumlichkeiten sind etwas niedrig gehalten. Als erstes betritt man den Umkleideraum, dem sich ein weiterer zur ausgiebigen Wäsche, der eigenen und der durch bodenkundliche Tätigkeiten reichlich verschmutzten Kleidung, anschließt und der den Durchgang zur Sauna ermöglicht. Ein rustikaler Ofen, in welchen Holzscheite von Meterlänge eingeworfen werden erwärmt alles. Besonders die Sauna und ein Fass zur Warmwasserbereitung. Temperaturen von 110°C und mehr sind keine Seltenheit. Ein weiteres 200-Liter Fass beherbergt die Kaltwasservorräte. Die reichlich vorhandenen Schüsseln ermöglichen fasst zeremonielle Körperpflege. Ähnlichen Charakter hat auch der eigentliche Saunagang. Die Zeremonie findet ihren Höhepunkt in der Massage durch eingeweichte, junge Birkenreiser, Weniki genannt, die der Banya einen außerordentlich angenehmen Geruch verleihen. Im Laufe der Zeit gab es einige Neuerungen und Reparaturen. Verrußte Decken künden davon, dass die Abgase nicht immer ihren Weg durch den Schornstein fanden.

Wie bereits im letzten Wochenbericht erwähnt, konnte in diesem Jahr mit dem Erweiterungsbau der Forschungsstation Samoylov, der vom AWI finanziert wird, begonnen werden. Die Erweiterung umfasst

insgesamt 62 Quadratmeter und wird nach der Fertigstellung in diesem Herbst direkt mit dem älteren Gebäudeteil verbunden sein. Es werden dann zusätzlich zu den bereits vorhandenen Räumlichkeiten (1 Damenschlafraum, 2 Labore und 1 Küche) zwei weitere Schlafräume, ein großer Aufenthalts/Arbeitsraum und eine innenliegende Toilette zur Verfügung stehen. Die Erweiterung schafft den dringend benötigten Platz, um dem steigenden Forschungsinteresse des AWI und seiner Kooperationspartner im Umfeld unseres bereits seit 1998 betriebenen Dauermessfeldes zur Spurengasdynamik und den Energie- und Wasserbilanzen gerecht werden zu können. Darüber hinaus werden damit die Voraussetzungen geschaffen, unsere Studien zum terrestrischen Methankreislauf und zu den zugrundeliegenden mikrobiellen Prozessen dann auch auf die besonders interessanten Auftau- und Rückfrierphasen der Permafrostböden im Frühjahr und Herbst ausdehnen zu können. Eine Aufgabe während der für das nächste Jahr geplanten Expedition ins Lenadelta wird daher darin bestehen den Anbau entsprechend unserer Forschungsaufgaben auszustatten.
In diesem Jahr nehmen neben unseren langjährigen Hamburger Kooperationspartnern, erstmals die Kollegen vom GSF-Forschungszentrum für Umwelt und Gesundheit (Helmholtz-Gemeinschaft) an der Lena-Delta-Expedition teil. Aufgrund der Erkenntnisse aus der bereits seit zwei Jahren andauernden Zusammenarbeit zwischen dem GSF und dem AWI, haben wir in diesem Jahr ein Feldexperiment gestartet, dass sich mit der Stoffwechselaktivität der Methan bildenden Bakterien unter den extremen Bedingungen des Permafrostes beschäftigt. Dazu wurden Permafrostsedimente aus dem immer gefrorenen Bereich mit 13C-markierten Substraten (Acetat, Methanol, Kohlendioxid) versetzt und bei Minustemperaturen inkubiert. Die weitere Auswertung des Experimentes, die in Neuherberg und Potsdam erfolgt, soll Kenntnisse zur zukünftigen Methandynamik von Permafrostlandschaften und Leben in extremen Habitaten liefern.

Den nächsten und zugleich letzten Wochenbericht werden wir voraussichtlich schon aus Tiksi versenden. Von dort werden wir, wenn alles wie geplant verläuft, am Donnerstag, den 29. Juli gen Moskau aufbrechen.

Mit herzlichen Grüssen in die Heimat,
Daria, Molo, Lars, Andreas & Dirk

Wochenbericht Nr. 10, 26.07.2004

Werte Leser, liebe Angehörige, Kollegen und Lieblingsmenschen,

der letzte Wochenbrief sollte der letzte dieser Saison von der Insel Samoylov gewesen sein. Es änderte sich nicht der Plan, nur das Wetter, und das ließ am heutigen Montag keinen Flugverkehr zu. Insider müssten es jedoch besser wissen: Montags nie!!! Doch das kann man von hier aus nicht nachvollziehen. Die Wetterprognose für Tiksi war Schneeregen bei Temperaturen knapp über Null. So bleibt uns zumindest jetzt ein Tag des Erholens nach der recht stressigen Packphase, einige Stunden des bewussten Genießens der Schönheiten dieser Insel im Zentrum des Lenadeltas und ein Teil der für Tiksi geplanten Arbeiten können schon hier erledigt werden.
Das Wetter der vergangenen Woche gestaltete sich wieder außerordentlich abwechslungsreich. Abhängig vom Wind und der Temperatur gab es Mückenmaxi und -minima. Letztere recht ausgeprägt und nur vereinzelt traten von früheren Expeditionen bekannte Plagen auf, die dem Forscher die Tätigkeit in der Tundra regelrecht verleiden können. Verglichen mit den Vorjahren fiel dieser Sommer ähnlich dem europäischen, ausgesprochen kalt aus. Man kann eben nicht alles haben.
Neben den zu Expeditionsschluss zusätzlich anstehenden Arbeiten, mussten - wie fasst alljährlich zu dieser Zeit - in der vergangenen Woche gleich mehrere Geburtstage gefeiert werden. Man wird auf Trauminseln halt auch älter und die Tage danach nicht leichter.
Und dann abermals eine MI8, Hubschrauber der Grenztruppen in der Luft. Etwas Unruhe, kurze Kontrolle der noch nicht Kontrollierten und die Profilansprachen konnten in aller Ruhe fortgeführt werden. Der Forscher als solcher gewöhnt sich besonders hier auch an so Einiges.
In der letzten Woche wurde von der Banya berichtet. Eine weitere und für unsere Arbeit unabdingbare Einrichtung ist der Lednik, eine überdimensionale Kühltruhe, die auch ohne Stromversorgung funktioniert. Nur für die Beleuchtung muss gesorgt werden. Der Dauerfrostboden ermöglicht es, dass in einer ca. 5m tiefen Grube Temperaturen von etwa -9°C realisiert werden können. Diese Grube wurde mühsam in den Permafrost geschlagen und hat ein Volumen von 20 bis 25 qm. Eine vereiste Leiter mit ungenormten Sprossenabständen ermöglicht den Einstieg durch eine Luke in der Decke ins unterirdische Reich der Kälte. Der erste Blick fällt auf die wunderschönen Eiskristalle an Decke und Wänden, der

zweite lässt den waren Grund dieser Einrichtung, der Lebensmittelkonservierung, erkennen. Säuberlich auf dem Boden sind Fisch und Fleisch ausgebreitet, teilweise auch unsere Ernährungsgrundlage während des Aufenthaltes auf der Insel, etwas seitlich dann unsere Transportkisten für gefrorenes Probenmaterial. Mittels einer manuell betätigten Seilwinde, wie man sie von mittelalterlichen Brunnen kennt, werden die Lasten nach unten und wenn benötigt wieder nach oben gekurbelt. Der ganzen Konstruktion etwas Vertrauen abzugewinnen erfordert immer etwas Mut zum Risiko.

In der letzten Woche wurden dann zwei ausführliche Bodenbeprobungen durchgeführt. Daria, Andreas und Dirk haben eine Beschreibung für je ein Bodenprofil im Polygonwall und –zentrum durchgeführt und anschließend für weitere geochemische und geomikrobiologische Studien in Potsdam beprobt. Diese Untersuchungen stehen in Zusammenhang mit dem bereits erwähnten „Mars-Projekt". Diese Proben dienen Untersuchungen zur Überlebensfähigkeit von methanogenen Bakterien unter extremen Umweltbedingungen. Am Ende dieser Studien wird eine Simulation der Umweltbedingungen, wie sie auf dem Mars herrschen, stehen. Die Marssimulation wird in Zusammenarbeit mit dem Deutschen Zentrum für Luft- und Raumfahrt (DLR) in Köln durchgeführt. Dort haben wir die Möglichkeit Permafrostproben und Bakterienkulturen in einer Kammer bei –80 °C, einer Strahlung von 200 nm, einem Druck von 6 mbar und einer Atmosphäre ohne Sauerstoff auszusetzen. Dieses Experiment wird zeigen ob und wie lange die Bakterien Bedingungen wie sie heute auf dem Mars herrschen überleben können. Permafrostböden sind eine natürliche Quelle des Treibhausgases Methan. Dieses Methan entsteht beim Abbau von organischem Material (z.B. Pflanzenrückstände) durch verschiedene Mikroorganismengruppen an deren Ende die sogenannten Methan bildenden Bakterien stehen. Ein Verständnis der saisonalen und räumlichen Schwankungen der Methanfreisetzung aus Permfrostböden und eine Abschätzung der zukünftigen Entwicklung dieser Landschaften bezüglich der Treibhausgasemissionen ist nur möglich, wenn die zugrundeliegenden mikrobiellen Lebensgemeinschaften in ihrer Zusammensetzung (Struktur) und Funktion bekannt sind. Diese Thematik soll Gegenstand eines gemeinsamen Forschungsvorhabens zwischen dem AWI und GSF werden, wozu eine sehr detaillierte Beprobung eines Polygons (typische Frostmustererscheinung) durchgeführt wurde. Insgesamt wurden über die Fläche des Polygons und in verschiedenen Tiefenlagen fast 100 Proben entnommen, die mit modernen molekularbiologischen Methoden in Neuherberg und Potsdam untersucht werden.

Wir hoffen, dass dieses der letzte Wochenbericht der Expedition LENA 2004 sein wird und freuen uns nun auf das Wiedersehen mit den Zurückgebliebenen und Lieblingsmenschen.

Mit herzlichen Grüssen in die Heimat,
Daria, Molo, Lars, Andreas & Dirk